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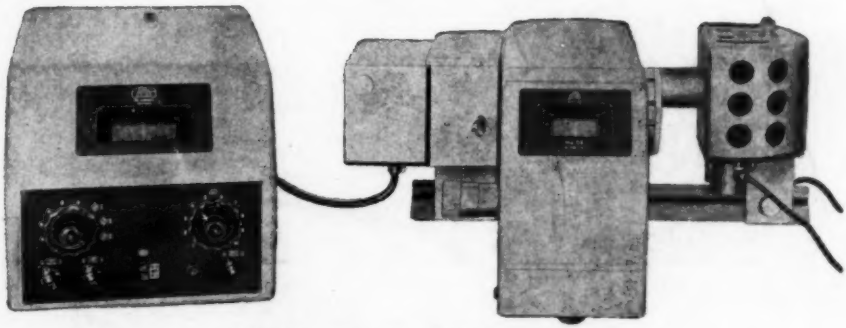

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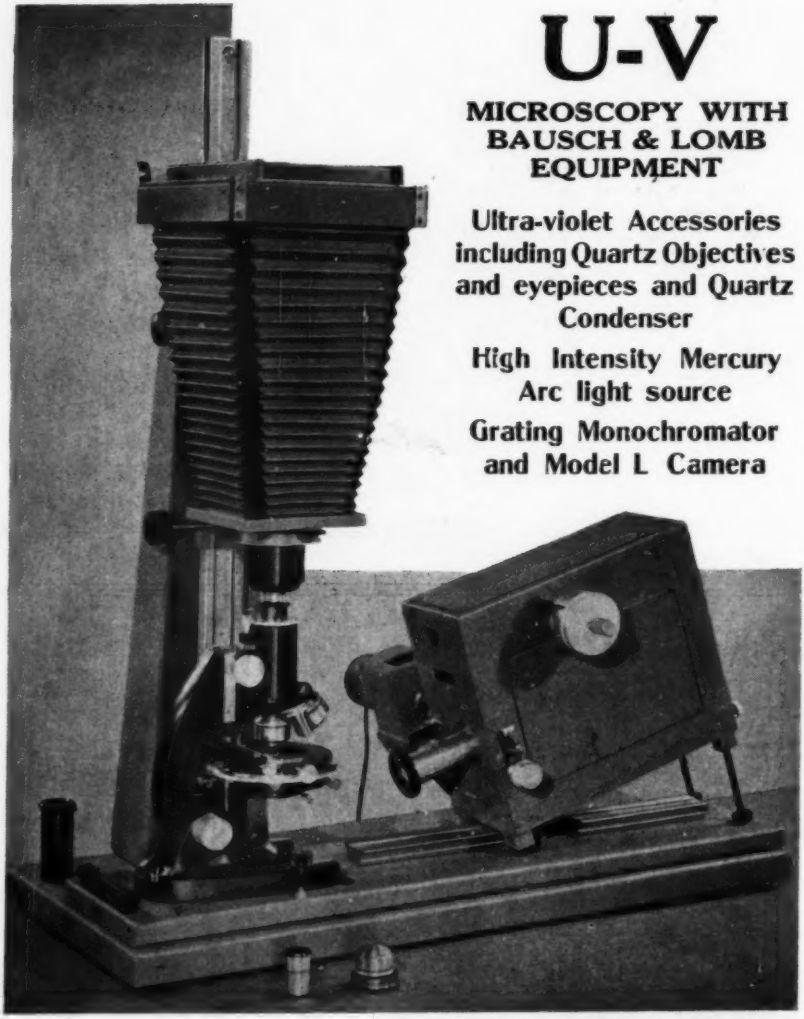

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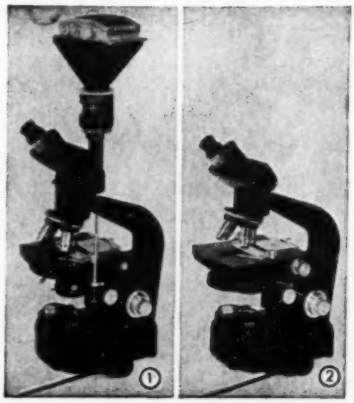

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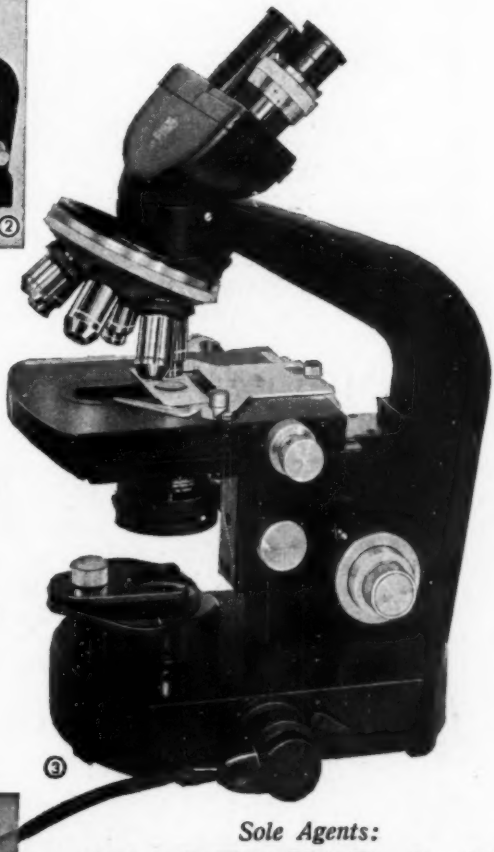

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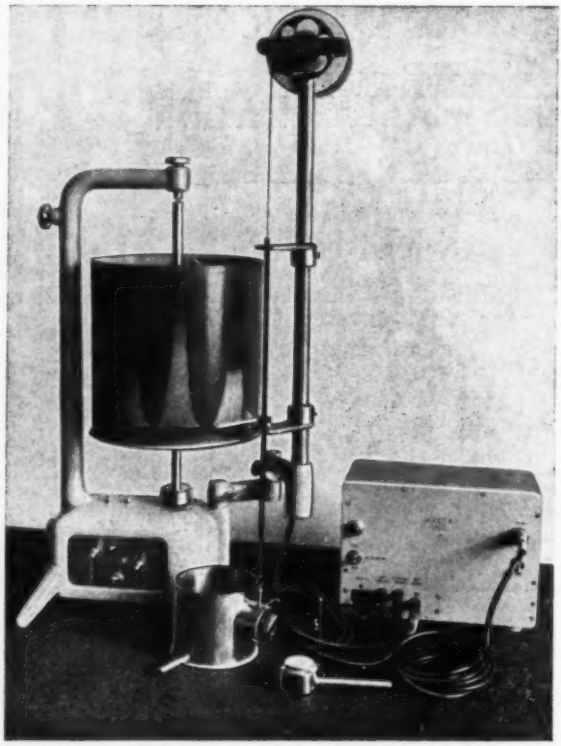

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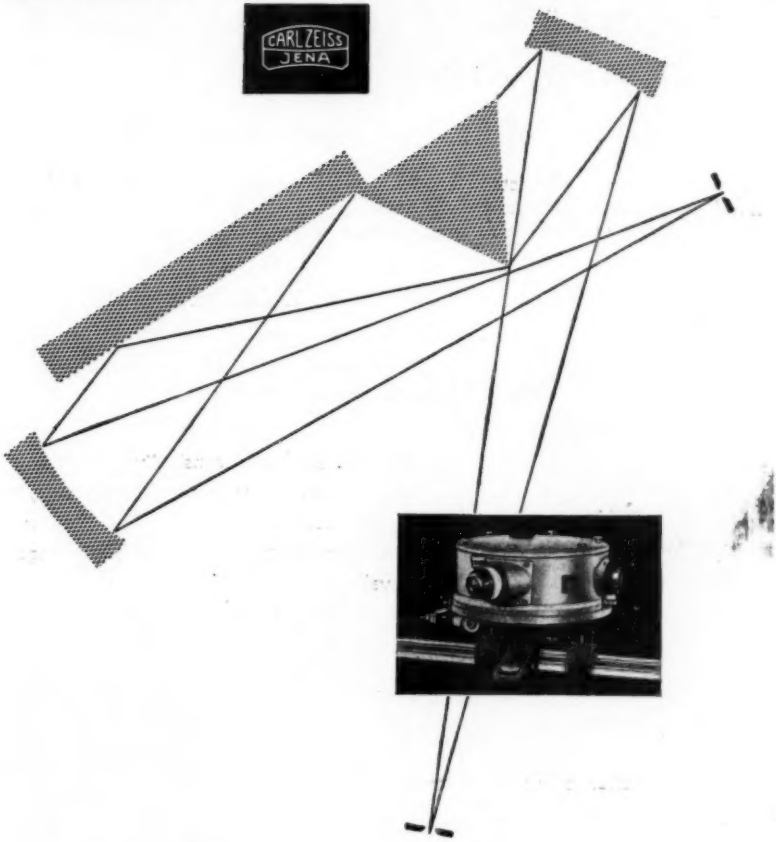

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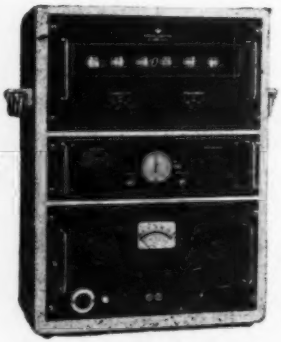

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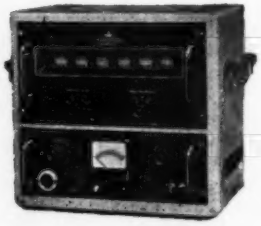

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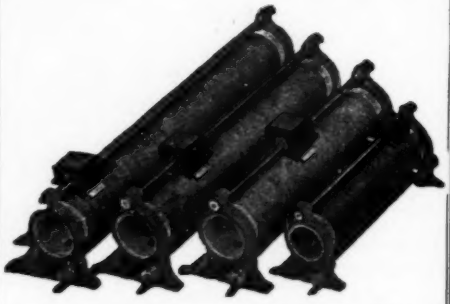

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NUCLEAR MAGNETIC RESONANCE AND ITS APPLICATIONS

1. Introduction

In order to account for the hyperfine structures in atomic spectra Pauli put forward the suggestion in 1924 that the nucleus should possess an angular momentum and a magnetic moment. It is therefore to be expected that materials which are otherwise diamagnetic should exhibit a weak paramagnetism if the nuclei within them have a magnetic moment. This nuclear paramagnetism was first demonstrated for solid hydrogen by Lasarew and Schubnikov in 1937, employing conventional magnetic methods.

The atomic beam experiments of Stern and Gerlach paved the way for the study of magnetic moments by beam deflection methods, which ultimately led Rabi and his colleagues to introduce the resonance technique employing molecular beams. These elegant molecular beam experiments successfully demonstrated nuclear magnetic resonance for the first time. That the resonant exchange of energy between the levels split by the application of an external magnetic field should also be observable with matter in bulk, containing nuclei possessing a magnetic moment was realised as early as 1937 and several attempts were made by Gorter and Gorter and Broer to observe the phenomenon but without success. The first successful nuclear magnetic resonance experiments using bulk material were reported in 1946 by Purcell, Torrey and Pound and quite independently by Bloch, Hansen and Packard. In the thirteen years that have elapsed since the announcement of these experiments, the subject of nuclear magnetic resonance has had a phenomenal development, and many are its applications which cover different branches of science. To mention a few examples, the technique is used to investigate structural problems in chemistry, as an analytical tool, and to control magnetic fields to a high degree of stability. In this article the basic concepts of nuclear magnetic resonance, the experimental techniques involved and some applications will be briefly set out.

2. Basic Concepts of Nuclear Magnetic Resonance

Atomic nuclei made up of odd number of nucleons possess an intrinsic angular momentum and are characterised by a spin number designated as I, which may be an integer or half integer. The largest measurable component of this angular momentum is given by $I\hbar$ where $\hbar = \frac{h}{2\pi}$. Such nuclei have usually a magnetic moment associated with them. For our present purpose this quantity is of interest and we shall examine the behaviour of a nuclear magnet having a magnetic moment μ when placed in a steady magnetic field H_0.

The classical treatment of such a system is due to Larmor and the magnetic dipole having a magnetic moment executes a Larmor precession about the direction of the steady field H_0 as its axis.

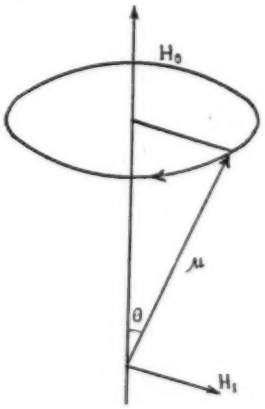

FIG. 1

Figure 1 illustrates a dipole precessing about the direction of the applied field. The rate of precession is given by the well-known Larmor angular frequency condition, $\omega_0 = \gamma H_0$ where γ is the gyromagnetic ratio of the dipole. If now a magnetic field at right angles to H_0 in the plane containing μ and H_0 is applied, the dipole will experience a couple. When the small field H_1 is made to rotate about H_0 as axis, in synchronism with the precession frequency, this couple will cause the angle θ to increase. A resonance therefore occurs when the angular frequency of the rotating field is equal to the angular frequency of Larmor precession, namely, $2\pi\nu_0 = \omega_0 = \gamma H_0$. Here it may be noticed that the small R.F. magnetic field has to have circular polarisation. However, it is not necessary to supply circularly polarised R.F. radiation. Linear polarisation is quite adequate, since it can be regarded as the superimposition of two

circularly polarised fields rotating in opposite senses. Resonance will be obtained with the component having the correct sense, the other one having a negligible effect.

This classical resonance condition agrees exactly with that derived from quantum theory. The energy levels of a nuclear magnet are split into $(2I + 1)$ values of $-m\mu H_0/I$ when placed in a steady magnetic field of strength H_0.

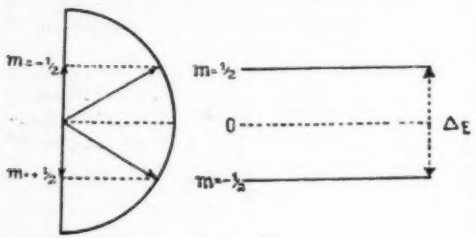

FIG. 2

In Fig. 2 these are illustrated for $I = ½$. A quantum of energy

$$\Delta E = h\nu_0 = \frac{\mu}{I} H_0 = g\mu_0 H_0$$

can therefore excite transitions between the levels if it satisfies the above resonance condition. Here ν_0 is the frequency of the electromagnetic radiation and g is the splitting factor or g-factor $(g = \mu/\mu_0 I)$ and μ_0 is the nuclear magneton $= \frac{e\hbar}{2\pi m_p C}$ where m_p is the mass of the proton. In general, the selection rule for a transition is for a change of $m = \pm 1$. For the proton to which the spin number ½ is ascribed, the change is from $+ ½$ to $- ½$, the two states having different energies. These two states correspond to the nuclear magnet being parallel and anti-parallel to the applied field. Transition can be induced from the lower state to the higher state by applying suitable radiofrequency power. For the proton, the value of g is approximately 5·58 and in a typical field of 5,000 gauss the resonance frequency works out to 21·3 Mc./s. For other nuclei, resonance occurs in the convenient radiofrequency region for comparable fields.

Thus, nuclear magnetic resonance is an absorption process involving electromagnetic radiation in the radiofrequency region. This absorption is directly related to the ratio of the number of nuclei in the higher energy to the number in the lower energy state. If the number of nuclei in each energy state were equal, no net absorption of radiation could result, for the probability for the transition upwards by absorption is equal to the probability of transitions downwards by stimulated emission. Actually, however, since the nuclear spins are in thermal equilibrium with the surrounding, the population of the lower level exceeds that of the upper level and is given by the Boltzmann's factor $\exp(2\mu H_0/kT)$ where k is the Boltzmann's constant and T is the temperature of the substance. On account of this small but finite excess of population, there is a net absorption of energy from the radiation field and the system is subjected to a process of radiofrequency heating. Due to spin lattice interaction, however, the heat is transferred to the lattice and the population to the lower level is restored. In the event of the system being supplied with a large dose of R.F. power saturation would result.

The important quantity in nuclear magnetic resonance is the spin lattice relaxation time T_1 which is the time constant for the attainment of thermal equilibrium between nuclei and its surrounding. One might say that T_1 describes the rate at which a hot spin system cools off exchanging energy with the surrounding, commonly designated as lattice. The values of T_1 which are encountered experimentally usually lie within the range 10^{-4} to 10^4 sec. It is found to be longer for solids than for liquids and gases. It may be remarked here that the presence of paramagnetic ions in a liquid promotes the relaxation process and may reduce T_1 to less than 10^{-4}.

The relaxation time T_2 which is connected with spin interaction is of importance and describes the life-time or phase memory time of a nuclear spin state where $T_2 \sim 10^{-4}$ sec. Each nuclear magnet finds itself not only in the steady applied magnetic field H_0 but also in a small local magnetic field H_{local} produced by neighbouring nuclear magnets. The direction of this local field differs from nucleus to nucleus and varies over a range of $H_{local} = 5$ gauss. As a consequence, there will be a distribution of the frequencies of their Larmor precession covering a range of $\delta\omega_0 \sim 10^4$ sec.$^{-1}$ If two spins have precession frequencies differing by $\delta\omega_0$ and are initially in phase, they will be out of phase in a time $\sim 1/\delta\omega_0$. Since the relative phases change in a time $\sim 1/\delta\omega_0$ the correct phasing for this spin exchange process should occur after a time interval of this order and this would determine the life-time of a spin state. This produces a broadening of the energy levels and results in the broadening of the resonance line.

Nuclear Induction

In a steady magnetic field the nuclear magnets absorb power from a suitably applied R.F. field. From a macroscopic point of view this absorption may be described by means of the imaginary part of χ of the complex nuclear magnetic susceptibility $\chi = \chi' - i\chi''$ of the assembly. We will not go into details of this treatment except to remark that the applied radiofrequency field produces an in-phase magnetisation and an out-of-phase magnetisation.

The amplitude of the in-phase and quadrature components are proportional to χ' and χ'' respectively. Suitable experimental arrangements were devised for the first time by Bloch and his group to amplify these components directly. Since the e.m.f. is obtained by electromagnetic induction from the precessing resultant magnetic moments, Bloch named the phenomenon *nuclear induction*.

3. Experimental Methods

Two experimental methods have been devised to study nuclear magnetic resonance. The basic requirements for observing resonance are the following. A sample material about one cubic centimetre in volume containing the nuclei of interest is subjected to a steady magnetic field. A time larger than T_1 is given for the spin system to come into thermal equilibrium with the lattice in the steady field. A coil is wound round the sample contained in a tube, before it is placed in the steady magnetic field such that its oscillatory field is at right angles to the steady field. Provision must be made to vary the field H_0 to obtain the resonance condition, if the frequency is kept constant. Although the frequency could be varied, the former arrangement, namely, varying the magnetic field is much more convenient and is widely adopted for detailed work. The resonance effects are detected by their reaction on the circuit supplying the radiofrequency field. At resonance, the radiofrequency power absorbed causes a decrease in the Q factor of the circuit which produces a drop in R.F. voltage across it.

This R.F. voltage is amplified, rectified and suitably displayed. For displaying resonance, the steady magnetic field is modulated at low audiofrequency of about 25 c.p.s., and the same low frequency voltage drives the horizontal sweep of the oscilloscope. With a highly homogeneous magnetic field and observation under steady state conditions, the oscillogram gives a faithful reproduction of the variation of χ'' with the magnetic field at the fixed frequency. A simple arrangement due to Rollin is shown schematically in Fig. 3.

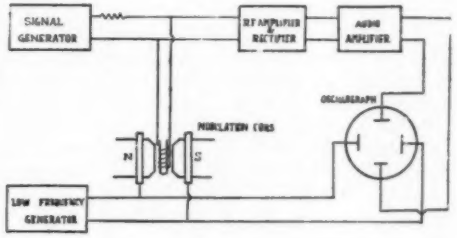

FIG. 3

In order to get a higher sensitivity, bridge circuits have been employed which allow more radiofrequency amplification before detection and also enhance the depth of modulation. In the bridge method the dummy circuit is adjusted such that the net voltage produced by it and the circuit containing the experimental material is made to approach null condition. The experimental material is placed in the coil of the test circuit and the latter is located in a homogeneous steady magnetic field. When resonance occurs the bridge is thrown out of balance and a small complex R.F. voltage equal to $V_0 [1 - 4\pi\zeta Q (\chi'' + 2\chi')]$ is produced. Here ζ is the filling factor and Q is the quality factor. Usually, the bridge is not balanced to null and the small resultant voltage V_1 combines with the complex voltage and the vector sum of the two voltages is given by $|V_{sum}| = |V_0 - V_1| + 4\pi\zeta Q |V_0| (-\chi'' \cos\phi + \chi' \sin\phi)$. As the modulated field sweeps through the region of resonance, a curve is traced out of the form $(-\chi''\cos\phi + \chi'\sin\phi)$. When the phase balance of the circuit is adjusted to $\phi = 0$ or π the plot obtained is the absorption curve and when it is $\phi = \frac{1}{2}\pi$ or $\frac{3}{2}\pi$ the dispersion curve is obtained. In the former case, the unbalance of amplitude results in an amplitude modulation of the R.F. voltage, while an unbalance in phase in the latter case produces phase modulation of the R.F. voltage if V_0 and V_1 are of equal amplitudes.

In order to obtain higher signal to noise ratio, the so-called phase detector or the phase sensitive amplifier is incorporated in the detector system.

While the bridge method has a wide applicability, it is not convenient for use when searching for unknown lines. The marginal oscillator method is especially suitable for such purposes. In this, the regeneration of an oscillator is adjusted to such a level that the circuit can just

sustain oscillations. The specimen is kept in the coil of the oscillator and when resonance takes place the R.F. absorption produced is equivalent to an increase in the positive shunt resistance and the oscillation amplitude falls. Thus the R.F. voltage is amplitude modulated at the rate of frequency at which the steady magnetic field is swept. This can be rectified and the audio output obtained can be amplified and displayed. A number of circuits of this type have been devised. Based on this, proton magnetic resonance field meters have been developed for accurate measurement of magnetic fields.

We now pass on to the second kind of experimental set-up devised by Bloch and his collaborators to study magnetic resonance. In this method, two coils are employed, one as the transmitter coil and the other as the receiver coil. In the actual experimental arrangement the receiver coil is wound close to the specimen and the transmitting coil is wound outside on suitable formers. This arrangement is placed in the steady magnetic field such that the two coil axes and the field lines are mutually perpendicular. The receiving coil is tuned by a parallel condenser and forms the input circuit of the first stage of a radiofrequency amplifier. This two-coil arrangement constitutes the principal part of the so-called R.F. head, and leads are brought out for connections. The R.F. head is well shielded to reduce any direct pick up by it, of the magnetic field modulation voltage. At resonance an e.m.f. is induced in the receiver coil by the precessing nuclei.

A very desirable requirement here is that the two coils should be perfectly orthogonal, in order to reduce direct pick up of the primary flux by the receiver coil. It is however not possible in practice to achieve this geometric condition and the presence of a small leakage signal as it is called can indeed be put to good use.

As stated earlier, the precessing nuclear magnetic moment has a dispersion part proportional to χ' and an absorption part proportional to χ''. The dispersion signal and the leakage signal are in quadrature and produces a phase modulation, while the absorption signal and the latter are in phase and produce amplitude modulation. The leakage flux can be controlled by mounting a semicircular sheet of metal called a 'paddle' at the end of the transmitter coil and rotating it. This, in combination with a resistance-capacity network, with a variable condenser feeding R.F. voltage from the transmitter coil to the receiver, enables one to obtain a leakage signal either in phase or in quadrature. A rectified signal could be obtained representing only the absorption proportional to χ'', when the quadrature component is completely compensated by adjustment of the condenser, leaving the in-phase component incompletely compensated by adjustment of the paddle. If, on the other hand, the in-phase component is completely compensated and the quadrature component is incompletely compensated, the dispersion signal proportional to χ' can be obtained.

One important piece of information which the nuclear induction method yields is the sign of the gyromagnetic ratio which cannot be obtained by the other methods. Apart from this there is nothing much to choose between single and double coil methods.

Pulse methods have been used for the study of transient effects. The study of transient behaviour enables experimental values of the two relaxation times T_1 and T_2 to be derived.

4. Application of Nuclear Magnetic Resonance

Among the applications of nuclear magnetic resonance the chemical application occupies a unique place and the NMR technique has already become a cherished tool of the chemists. These applications are possible because, the detailed characteristics of the magnetic resonance are very sensitive to various features of the nuclear environment. When a molecule possesses several resonant nuclei of the same species, but in different electronic environments, each nucleus gives a different resonance frequency. This phenomenon is known as 'chemical shift' and arises due to the fact that the nuclei in the different environments find themselves in a magnetic field, different from that of the applied field, due to the difference in the shielding effect produced by the molecular electrons. By measurement of the chemical shifts with substances either in the liquid form or in solution, a direct measure of the intramolecular shielding could be obtained. The so-called 'chemical shifts' can be used as an analytical device, in much the same way as infra-red spectroscopy. Chemical shifts can also be used to study chemical equilibria in solution.

These applications take us to what is known as High Resolution NMR Spectroscopy where the stability and homogeneity of the static magnetic field is kept better than 1 part in 10^7. Instruments are now available for high resolution work and particular mention should be

made of Varian spectrometers. Studies on hindered internal rotations, proton exchange behaviour and determination of organic structures have been extensively carried out by employing NMR technique.

In the short span of a little over ten years time, NMR Spectroscopy has emerged out as a powerful tool for the study of the problems connected with matter in different states of aggregation. Its usefulness as a practical tool can be judged from the fact that it is already a commercial instrument and is used for routine analytical purposes. We may expect a further widening of its applications in the years to come.

A. JAYARAMAN.

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ATOMIC STANDARDS OF LENGTH AND TIME

THERE is little doubt that atomic standards will serve to define the fundamental units of length and time within the next decade. They are already in wide use and are proving themselves not only more precise but far more convenient and accessible than the standards which are the bases of the present definitions. A recommendation to establish a metre equal to 1 650 763·73 vacuum wavelengths of the orange radiation ($2p_{10}$—$5d_5$) of the krypton atom of mass 86, is to be submitted in 1960 for formal approval by the 11th General Conference of Weights and Measures. Recent work indicates that the wavelength of the recommended line, $6057{\cdot}8021_1 \times 10^{-10}$ m. when emitted from the hot-cathode krypton lamp at 63° K. and corrected for the small departures from the ideally specified conditions of excitation, is reproducible to about 1 part in 10^9.

There is some prospect of establishing the second of time in terms of the frequency of an atomic (or molecular) radiation, with a reproducibility of 1 part in 10^{10}, when the General Conference meets again in 1966. A line in the hyperfine structure of the caesium atom promised to be particularly suitable as a standard because its frequency near 9200 Mc./s. (wavelength 3 cm.), is very convenient for the electronic equipment. Moreover, caesium atoms are the easiest of all to detect, and they can be produced in a simple manner by heating to about 150° C. a mixture of caesium chloride and sodium. Rigorous tests carried out in the Standards Division, National Physical Laboratory, Teddington, on the caesium atomic clock since it was put into operation in 1955, have given such convincing evidence of its reliability, reproducibility and ease of application that it is already accepted to be the most accurate of all standards of measurement, including the astronomical, for the unit of time interval. As at present established the frequency of this line of caesium, F, m (4, 0) $\rightleftharpoons$ F, m (3, 0) at zero field = 9192 631 770 ± 20 c/s.

Appropriate means will, however, need to be devised to correlate and harmonise, as and when found necessary, the units of time furnished by the astronomical and atomic standards. Both these must continue to be used, the former for the long term purposes of astronomy and the latter to meet the immediate needs of physics and radio-engineering. After many years have elapsed it should be possible to ascertain whether there is any difference between atomic and astronomical scales of time—a matter of some cosmological interest.

In the present state of knowledge there seems little hope of defining the fundamental unit of mass in terms of a natural standard, *e.g.*, an elementary particle, atom or molecule, with the precision of 1 part in 10^8 ascribed to the existing material standard. Attention has been drawn, however, to the possible use of the gyromagnetic ratio of the proton as the means of defining a third basic unit (probably the gauss). This with the units of length and time, also depending on atomic characteristics, might provide in the future the stable foundations of a comprehensive system of measurement for all other physical quantities.—(H. Barrell, *Science Progress*, Vol. XLVII. April 1959, No. 186).

HYDROBIOLOGY SERVES FRESHWATER FISHERY IN NEW CHINA

CHANG TSUNG-SHEH

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CHINA is a country rich in freshwater fishery resources. According to incomplete statistical data, the total freshwater area (including rivers, lakes, ponds, etc.) amounts to about one million hectares. The Yangtze, Pearl and Amur rivers contain large quantities of fish. Lakes are dispersed all over the country, about 100 of them being large lakes of more than 10,000 hectares with far more medium and small-sized ones. All these are excellent for fishery. History records that as far back as the 5th century B.C. pisciculture existed in China. Endowed with the experiences of generations the Chinese selected and cultivated such delicious and fast-growing fishes as the *Mylopharyngodon* (Black carp), *Ctenopharyngodon* (Grass carp), *Hypophthalmichthys* (Silver carp) and *Aristichthys* (Big head). Freshwater pisciculture was always of considerable importance to China's national economy, producing about 30% of the total fish harvest.

Scientific Research

Like all other branches of science, hydrobiology has progressed rapidly in New China with the development of freshwater fishery. The Institute of Hydrobiology of the Academia Sinica is the chief centre of the scientific research into freshwater fishery. The Institute was founded in 1950 at the same time as the Academia Sinica was established. In 1954, it was moved to the East Lake of Wuhan, capital of Hupeh Province, which is surrounded by lakes and ponds. Facilities now include a new research building, experimental fish ponds, hot house, motor boats and other equipment. There are at present more than 100 research and technical workers on the staff, including many well-known professors and specialists (Prof. Chia-chi Wang, Protozoologist, Director of the Institute, and Prof. Hsien-wen Wu, Ichthyologist, the Vice-Director) and a large number of young assistants. They are working on ichthyology, fish parasitology and bacteriology invertebrate zoology, the biology of freshwater plants (both high and low) and the chemistry of water.

Lake Surveys

Most of China's lakes are distributed in the middle and lower Yangtze basin; one-fifth of the total freshwater area is located in Hupeh Province. In this region the temperature is above 20° C. for more than half the year and frost is rare. Therefore the growing period of fish is longer and fry of various pond fishes are produced and collected in this area which is favourable to freshwater pisciculture. In order to gain a scientific basis for large-scale fish-cultivation, the properties of the lakes must first be studied. In 1953, a general survey was made under the leadership of Prof. Jao Chin-chih. Medium- and small-sized shallow lakes of Hupeh, Anhwei and Kiangsu provinces along the Yangtze River were investigated. The survey covered 658 lakes, having a total area of more than 600,000 hectares. Rich in water plants and plankton, combined with other chemical properties and ecological conditions, most of such lakes proved to be of eutrophic type, especially suitable for rearing the four famous Chinese pond fishes. Besides, lakes of a special type such as the Chinghai Hu (Koko-Nor in Chinghai Province) and its surrounding smaller lakes in the North-West and lakes of the Yunnan uplands were investigated for productive possibilities. Preliminary investigations were also made of the fishery potentials of several reservoirs on the Huai River.

Prevention and Cure of Fish Disease

Formerly, the death rate caused by epidemic diseases in pond fishes was very high, reaching 40%, 60%, and even 90%. Fish disease spelt serious disaster to the fish farmers. Since 1953, scientific workers, under the leadership of Prof. Da-shu Nie, have investigated the main fish diseases in the chief districts of pisciculture and effective ways of treatment have been found. For example, it was discovered that the parasitic diseases of the gill of the grass carp (*Ctenopharyngodon*) were caused by parasitic protozoa (*Cryptobia*, *Trichodina*, *Trivhophrya*) and crustacea (of the family Ergasilidæ), and it was found that a mixed solution of ferrous and cupric sulfates is an effective remedy. An efficacious way to kill *Argulus* is the use of 666 and bacterial gill and skin diseases of the grass carp can be cured by using bleaching powder. The gastro-intestinal diseases of the grass-carp and black-carp also can be successfully controlled. With the aim of combining prevention and treatment, a series of piscicultural technological studies are being made (sterilising the fish ponds with lime, the use of mixed manure as fertilizer for raising natural fish food in ponds, and methods of fish fry transportation, etc.). The results of

these studies will play an important role in increasing pond productivity.

FISH PHYSIOLOGY, ECOLOGY AND ANATOMY

One of the key problems in freshwater pisciculture is to get fish fry. Up to now pond fish fry are procured from the rivers at a particular season of the year and then transported to other places for cultivation. There are many shortcomings in such a method : it is difficult to select and transport fry, it demands too much labour, the time for collection is too limited, etc. With the rapid development of pisciculture, the supply of fry will become to some extent a limiting factor. Inducing pond fishes to spawn in the stagnant waters of lakes or ponds is therefore of no little significance both theoretically and practically. Studies are being made to attack the problem from many sides (physiologically, biochemically and histologically). Some preliminary results regarding factors governing spawning have already been obtained.

The ecological survey of fish in the Liangtze Lake (458·5 square kilo metres), in Hupeh Province, has just been finished.

Detailed morphological studies of the carp are being made by Prof. Chi Ping (now of the Zoological Institute of the Academy).

Researches on planktonic algæ, zooplankton, fish and fish parasites are being carried out and some results have been published. The plan is to continue these studies and to publish serial monographs.

The problem clearly set before the hydrobiologists is the difficult one of raising the total fish yield. At the heart of the problem is the productivity of water bodies, whose resources, reserves and productive capabilities must first be investigated. Therefore, surveys of various types of lakes throughout the country will be continued and at the same time permanent stations will be established. In order to raise the productivity of the medium and small-sized lakes, research will be conducted under the following headings : the growth of fish in relation to their natural food ; the effect of artificial fertilization on water bodies ; the chemistry of freshwater ; the relationship between aquatic micro-organisms and productivity of water bodies ; the prevention and treatment of fish diseases, etc.

The multi-purpose utilisation of rivers is being developed rapidly in this country ; hydrotechnical construction will deeply affect fishery in the basins. How to ensure that hydrobiological research is suited to the changing hydrological aspects daily assumes greater significance. The ecological survey of fish in the Yangtze and the Heilunkiang (Amur) rivers has already begun. Investigation into the productivity of large water reservoirs will begin soon. The question of water pollution by the many newly-built factories will be given due attention.

All this work is being carried out in accordance with the needs of China's economic construction and at the same time these are also problems of importance to hydrobiology.

CELL AS AN OBJECT OF EXPERIMENTAL STUDY

UNDER the auspices of the Department of Zoology, Presidency College, Calcutta, a symposium was held on the 3rd May 1959 on the "Cell as an Object of Experimental Study". The purpose of this meeting was to try and bring about a synthesis of the various aspects of study of the Cell. Considering that this was the first attempt made in this direction in India the results were quite encouraging.

The fifteen papers presented at the symposium were rather diverse but stimulating.

A typical example, of the possibilities of Biological experimentation, was offered by B. R. Seshachar's studies on *Spirostomum*. He reported that the macronucleus of this ciliate could be extended to as much as fifteen times the original length. More recent experiments have shown that, under high speed centrifugation, it presented the appearance of a system of parallel fibres, quite unlike its characteristic particulate appearance, in the vegetative state. The interest in this work lies in the fact that it fits into the present concept of the structure of DNA which makes up much of the ciliate macronucleus.

The behaviour of the cell, under different conditions, gives us an idea of the substances that are essential for the synthesis of the ultimate cell products, and those that are detrimental to it. C. De and M. Mukherjee presented an analysis of the function of plasmalogen in different tissues like liver, kidney tubules, adrenals and testis. A number of experimental conditions, which alter hormonal activity in the last two organs, have been observed to affect the plasmalogen content also.

The importance of cell constituents like the microsomes was well brought out in the studies of liver and kidney by I. B. Chatterjee and his colleagues. These cytoplasmic inclusions contain all the enzyme systems for the conversion of either D-glucuronolactone or l-gulonolactone to l-ascorbic acid. The absence of l-gulonolactone in guinea-pig is thought to be due to a gene controlled enzyme disfunction.

In his work on reticulo-endothelial cells in tissue culture, J. Chatterjee showed that the antibody formation, initiated and continued by these cells, could be enhanced by certain vitamins or depressed by low temperatures.

It becomes more and more clear that for a complete investigation of any given material it is necessary to use not only the method of biology but of biochemistry and biophysics too. An example is found in the investigation of Sen and Biswas on auxin-induced growth in plants using P^{32}. Auxins, through increased activity of nucleotides, stimulate the synthesis of both DNA and RNA. Here both C^{14} and P^{32} were used as tracers.

A. Guha presented what he thought was evidence for the presence of a chromosomal organization in bacteriophage. S. P. Ray-Chaudhuri described his findings of radiation induced dicentric bridges. He showed that in grasshoppers kept in an atmosphere of more oxygen, radiation induced the production of more bridges than those in an atmosphere of less oxygen.

Dr. Nandi's paper on Ultraviolet Radiation on *Aspergillus niger* showed that visible light is able to counteract damages, done to cells, by exposure to UV irradiation, the photoreactivation effect being maximum with sunlight.

P. De's contribution dealt with an analysis of growth and functionation in normal and malignant cells, while A. K. Sharma discussed the role of plant pigments in the production of breaks and other changes in chromosomes. S. Mookerjee showed how in Hydra, the interstitial cells could be stimulated to gonad differentiation by treatment with DNA.

Cytochemical studies on Protozoan parasites undertaken in the Calcutta School of Tropical Medicine were described by Dr. H. N. Ray. These studies have brought out the importance of the nucleic acids as well as cell enzymes in the metabolism of these animals. Asoke Ghosh dealt with the probable role of progesterone in the metabolism of the pigeons adrenal cortex. P. N. Bhaduri's contribution dealt with recent refinements in the methods of culturing excised paddy embryos and their bearing on experimental induction of polyploidy.

The symposium highlighted the importance of close collaboration among Biology, Biochemistry and Biophysics.

DISCOVERY OF A NEW ATOMIC PARTICLE: NEUTRAL-χi

THE discovery of a new kind of atomic particle was announced from the radiation laboratory of the University of California. Called the "Neutral-χi" particle, it is one of the unstable heavy mesons, several of which have been discovered in the last twelve years.

The discovery had been accomplished by shooting a beam of "K mesons" from the bevatron in Berkeley into a hydrogen bubble chamber. The latter is a tank of liquid hydrogen arranged in such a way that atomic particles passing through it leave behind a trail of minute bubbles which can afterwards be photographed.

Prof. Alvarez said that the particle which has been observed was produced by a collision between a negatively charged K meson and a proton in the bubble chamber. In the photograph this would have been represented by a sudden cessation in the track of the K meson, for the products of the nuclear reaction are electrically neutral and so leave behind no visible track of bubbles.

The proof of the formation of the χi-meson rested on the observation of the "neutral lambda" meson formed in its natural radioactive decay (which appears to take about a ten-millionth of a second). This is a remarkable technical feat, for the "neutral lambda" is itself electrically neutral and therefore not represented by a track in the bubble chamber. In fact it was only recognised by the observation of its own radioactive decay products.

From these experiments, Prof. Alvarez said, it had been concluded that the mass of the new particle (which is greater than that of a proton) was roughly 2,590 times that of a single electron. Within the accuracy of the experiment this is identical with the mass of the negatively charged χi-meson—one of the first of the heavy mesons discovered by a research group from Manchester University in 1947.

Prof. Alvarez also said that the new particle appeared to decay spontaneously (as it should) into a neutral lambda meson and a neutral π-meson.—*Science Newsletter, 4718.*

INHERITANCE OF LEAF BLOTCHING IN AN INTERVARIETAL CROSS OF *TRITICUM AESTIVUM* L.

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AT the Botany Division, Indian Agricultural Research Institute, New Delhi, an extensive collection of wheat varieties, both Indian and exotic, is maintained. These are critically assessed for disease resistance and other desirable agronomic characters for utilizing them as direct introductions or in hybridization work for wheat improvement. Among the recently received wheats from the U.S.A., a hybrid variety Supremo × Montana (accession number, E. 1844), while showing high resistance to brown and yellow rusts, was found to develop symptoms of blotching in leaves during the two-year period for which it was under study.

Detailed observations on the development of blotching in leaves revealed that its symptoms first appeared in the older leaves about 50 days after the sowing of the crop and they subsequently spread also to younger leaves. The yellow-chlorotic spots occurred in patches at random in the leaves, their size being variable in the same leaf. At later stages, the tissues in these chlorotic zones dried up. When the incidence of such chlorotic patches was high, the whole leaf dried up. The leaves with typical blotching are shown in Fig. 1. The exact nature of this blotching, however, is not as yet known, though it has been established that the chlorotic patches are not caused by any fungus.

The variety, Supremo × Montana, was crossed with New Pusa 718, which has normal green leaves, with a view to finding out if this character was genetically controlled. The mode of inheritance of this character was studied for two years. During the year 1956-57, the F_1 and the F_2 generations of the cross were grown while in the subsequent year, F_3 progenies were also added. Casual observations made during 1956-57 showed the dominance of normal green leaves over blotched leaves in F_1 and the segregation of the two characters in accordance with the simple Mendelian ratio in F_2. During the year 1957-58, the F_1, F_2 and F_3 generations along with parents of the cross were grown in three replications. It is of interest to note that, during this year as well, the parent E. 1844 developed characteristic blotching of leaves in all the replications, while N.P. 718 had normal green leaves. The F_1 data confirmed previous year's observations that blotching in the leaves of E. 1844 was recessive to normal green leaves of N.P. 718. The segregations observed in the F_2 and F_3 generations are given in Tables I and II respectively.

TABLE I

The mode of inheritance of leaf blotching in the F_2 of the cross N.P. 718 × E. 1844

Material	Number of plants			χ^2	P. value
	Normal green	Blotched	Total		
N.P. 718 ..	155	..	155	..	..
F_1 ..	119	..	119	..	..
F_2 Observed ..	183	77	260	2·95	·10–·05
Expected (3 : 1)	195	65	..	..	..
E. 1844 ..	..	97	..	..	..

TABLE II

Segregation of leaf blotching in the F_3 of the cross N.P. 718 × E. 1844

Material	No. of families					
	Homozygous green	Heterozygous (3 : 1)	Homozygous blotched	Total	χ^2	P. value
F_3 Observed ..	4	9	7	20	..	..
Expected (1 : 2 : 1) ..	5	10	5	..	1·1	·95–·90

In the F_2, a large variation in the intensity of blotching was observed (Fig. 1). However, when all the plants showing even slight development of yellow spots were grouped together and compared with the normal green plants, the segregation showed a good fit to a monohybrid ratio of 3 normal : 1 blotched.

In the F_3, the segregation among the families showed a good fit to a ratio of 1 homozygous green : 2 heterozygous : 1 homozygous blotched. A further analysis of heterozygous families in this generation showed them to segregate in a ratio of 3 normal green : 1 blotched. The F_2 and F_3 data, therefore, prove conclusively that

blotching in leaves of wheat variety Supremo × Montana behaves as a recessive to normal green leaves of N.P. 718 and is inherited in accordance with a monohybrid ratio.

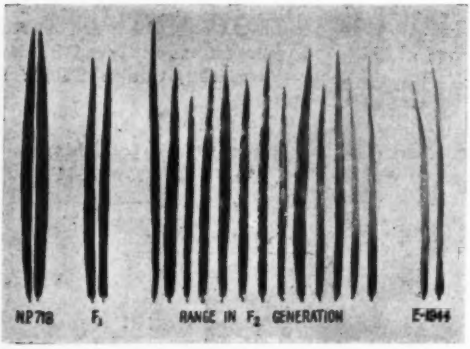

FIG. 1

With a view to finding out the association, if any, between blotching and grain yield, the F_2 data were subjected to 't' test. The results are summarized in Table III.

TABLE III

Grain yield comparison of normal green and blotched plants in the F_2 of the cross N.P. 718 × E. 1844

Material	Mean grain yield per plant (gm.)	Difference	't' value	P. value at 5% level
Normal green plants	17·84 ± 0·8217	..	..	..
Blotched plants..	17·12 ± 1·1345	0·72	0·489	1·959

It will be observed that the blotched-leaved phenotypes had slightly lower mean yield than the normal green-leaved phenotypes, though the difference between them was not significant statistically.

As far as the authors are aware, the occurrence of blotching in wheat varieties has not been reported before. Further work is in progress to find out the nature of blotching in the leaves of variety Supremo × Montana.

PHYSICAL PROPERTIES OF LIVING PROTEINS

ACCORDING to a report given by Soviet Scientist Prof. Lev Blumenfeld, living proteins have physical properties very similar to those of metals and a large group of substances, including ferrites, widely used in making mechanical memory devices and radio apparatus. The ferromagnetic properties of living proteins were discovered by means of an electronic paramagnetic resonator.

The essence of the phenomenon discovered is that living proteins can conduct electricity and are capable of magnetic polarisation similar to that which takes place on ferrites in mechanical memory devices. Experiments have shown that proteins and nucleic acids have no such properties when separated from each other. But as soon as these two polymers are combined they develop this property. A huge cloud of free (non-paired) electrons, up to 10,000 per molecule, is observed in the molecules of living proteins.

The experiments were conducted for a year with various preparations of the nucleic acids and natural proteins. It was established that the new phenomenon is much more pronounced in the experiments with younger, rapidly-growing tissues and with tissues of the marrow and the brain than in the experiments with artificial preparations.

Commenting on Prof. Blumenfeld's report, Acad. Kapitza pointed out that no one among the physicists who had worked on theory in this field had expected it to help to explain the basic phenomena of life.

The experiments carried out by Prof. Blumenfeld and his assistants open up a new way of studying the physical basis of life. The studies of the new phenomenon may even help to get a deeper insight into the laws of heredity and to understand the mechanism by which living matter "memorises" the so-called genetic code. This mechanism may, to a certain degree, be similar to a very complicated magnetic recording. Human memory probably has the same physical basis.—*Soviet News.*

LETTERS TO THE EDITOR

EFFECT OF SYNTHETIC SOIL CONDITIONERS ON THE CATION EXCHANGE CAPACITY OF SOILS AND CLAYS

RESULTS of previous workers[1–8] in this field show that cation exchange capacities of soils and clays may be affected by treatment with synthetic polyelectrolytes but their nature and extent remain purely conjectural, thus requiring further detailed studies. The present investigation was undertaken to find out the effect of three synthetic polyelectrolytes on the cation exchange capacity of typical Indian soils and clays.

Krilium Loamaker (100% active) supplied by Monsanto Chemical Co., U.S.A., hydrolysed polyacrylonitrile (HPAN) and a copolymer of styrene and Maleic acid (SMA) prepared by us were treated at the rate of 0·1% on dry basis with alluvial soil, black cotton soil (Nagpur), a soil rich in organic matter (Jalpaiguri) and bentonite and Rajmahal (Kaolin) clays (supplied by Calcutta Mineral Supply Co., Calcutta) under laboratory conditions. Soil conditioners were applied in a requisite amount of aqueous solution (¾ P.L.) by directing a fine spray into 250 g. of soils passing through 2 mm. round holes and clays (300 mesh). The whole quantity was thoroughly mixed and kept in suitable containers provided with lids. After treatment for 48 hours, the samples were gently passed through a 4 mm. sieve and air-dried. Each experiment and control was replicated four times and the average values are given in Table II. Cation exchange capacity was determined by ammonium acetate method.[9]

TABLE I

Physical properties of soils and clays

Soil or clay	Conductivity 10^{-3} × mhos/cm. at 25° C.	Moisture content per cent.	Sticky point	Porosity	Cation exchange capacity M.E./100 g.
Alluvial soil ..	2·05	1·976	22·63	51·92	13·46
Black cotton soil (Nagpur)	6·00	6·836	22·98	42·39	61·45
Soil rich in organic matter (Jalpaiguri)	0·24	1·720	..	57·02	12·18
Rajmahal clay (Kaolin)	1·36	0·852	23·14	54·77	20·02
Bentonite ..	8·25	11·53	33·87	47·59	62·51

TABLE II

Effect of synthetic soil conditioners on the Cation Exchange Capacity of soils and clays

Treatment	Cation exchange capacity M.E./100 g.				
	Alluvial soil	Soil rich in organic matter (Jalpaiguri)	Black cotton soil (Nagpur)	Rajmahal clay (Kaolin)	Bentonite
Untreated ..	13·46	12·18	61·45	20·02	62·51
Krilium ..	14·69	20·90	60·94	14·90	59·54
SMA ..	12·77	10·83	51·61	20·37	62·82
HPAN ..	12·65	13·83	52·19	10·20	62·96

The figures in Table II show that the cation exchange capacity of bentonite clay and alluvial soil is not appreciably altered by any of the three treatments. Similarly no marked change is observed in the cases of soil rich in organic matter (Jalpaiguri) treated with HPAN and SMA Black cotton soil (Nagpur) treated with Krilium and Rajmahal clay treated with SMA. However, Rajmahal clay with Krilium and HPAN, and Black cotton soil (Nagpur) with SMA and HPAN show a decrease in cation exchange capacity. The only case of increase is in the Krilium treatment of Jalpaiguri soil.

Minorulkeda[5] and Allison[8] studied the effect of soil conditioners on the cation exchange capacity of soils and reported increases in all cases. Archibald and Erickson[6] reported both increases and decreases from 0·02% VAMA treatment. However, Mortensen and Martin[7] reported that the cation exchange capacity of Hoytville silty clay was not altered by VAMA or HPAN treatment when applied at the rate of 0·12%. The present results show that no generalization regarding the changes in cation exchange capacity, as a result of treatment with synthetic polyelectrolytes, could be made. Evidently such changes are governed by (1) nature of the soils and clays, (2) nature of the polyelectrolytes and (3) concentration of the polyelectrolytes.

Thanks are due to Prof. Santi R. Palit, Professor of Physical Chemistry, for helpful criticism and suggestions and also to Prof. R. Ray,

Director, Indian Association for the Cultivation of Science, for providing laboratory facilities.

TRILOKI NATH.
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A SIMPLE LIQUID AIR TRANSFER VALVE FOR CONTROLLED EVAPORATION

IN connection with the installation of our helium liquefier we had to construct a siphon together with a liquid air transfer valve for transferring liquid air into partially evacuated system. On looking into the literature we found a liquid hydrogen transfer valve described[1] which is, however, too complicated for our purpose. Our main requirements are: (1) a long operating handle to prevent the freeze up of the valve, (2) a vacuum-tight seating for the valve which could easily open when there is a vacuum on the outlet side. We have therefore designed and constructed a very simple liquid air transfer valve meeting the above requirements.

Fig. 1. Sectional View of the Transfer Valve.
H = Operating Handle. G = Fibre Gasket.
P = Piston. E = Entry Port.
K = Stainless Steel Knob. O = Liquid Air Outlet.
S = Phosphor-bronze Seat.

The constructional details of the valve can be easily followed from Fig. 1. The outer sheath of the whole assembly (shown shaded) is made of stainless steel which carries the long hollow piston P (also of stainless steel) operated by the handle H. The piston moves over a small distance of a few mm., the clearance between the piston and the outer sheath being very small, of the order of one mm. or less. K is a stainless steel knob, which, slides loosely into the piston P but presses tightly against the phosphor-bronze seat S. E is the entry port for the liquid air, which is connected to the liquid air supply system through conventional type of fittings, such as petrol unions, etc. O is an outlet similarly connected by a siphon to the system, in which the liquid air is to be kept continuously evaporating at reduced pressure.

For starting the transfer, the piston is moved back when the liquid air enters through E, pushes the knob K and goes to the outlet O. The piston is kept in the horizontal position so that the force required to transfer the liquid has not to work against the weight of the knob, and is, therefore, considerably minimised. After the required amount of liquid has been transferred into the evaporation chamber, the piston is brought back to close the valve.

The design has the following special features:—

(1) Long and convenient size of the piston: As the threaded part of the piston is at a great distance any chance of the valve being blocked or jammed is considerably minimised.

(2) Vacuum-tight connections: The stainless steel knob and the phosphor-bronze seat enable a high vacuum to be obtained evaporating at a pressure of a few mm. of mercury. The mechanical seating of the valve is quite robust ensuring it a long life even in rough use.

Several such valves are in continuous use in our laboratory for feeding liquid air and have been found to be entirely satisfactory in operation. To minimise heat influx into the valve the portions near E and O are surrounded by glass wool.

The author wishes to express his thanks to Prof. B. N. Srivastava for his helpful discussions.

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INFLUENCE OF EXTERNAL ATMOSPHERE ON A/C SILENT DISCHARGES

WHILE investigating the effect of light on A/C silent discharge, it was noticed that the results were not always reproducible. For example, the current voltage and the negative light-effect voltage characteristics differed considerably at different conditions of the atmosphere surrounding the discharge tube. It was therefore thought advisable to study the effect under conditions where the latter could be controlled.

With this object in view the usual type of discharge tube was modified so as to have a coaxial glass enclosure which could be evacuated. The inner discharge tube contained iodine vapour and was fitted with two sleeve electrodes, of a few turns of copper wire each, kept at about 5 cm. apart. The electrode leads were brought out by sealing them through the glass of the envelope. The whole apparatus was heated to a temperature of about 400° C. and the envelope was evacuated and sealed off. After the discharge tube was cooled to the room temperature it was tried for the effect of light on A/C silent discharges using the conventional circuit.

A typical result obtained under these conditions is shown in Fig. 1. It is clear from the

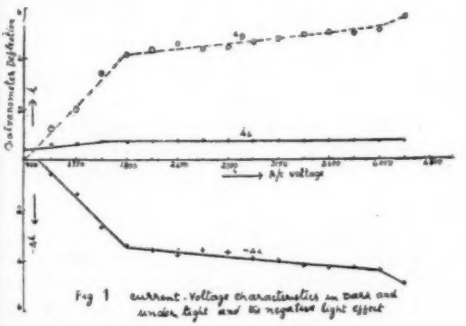

Fig 1 current-voltage characteristics in dark and under light and its negative light effect

figure that after the threshold potential the discharge current in dark (i_d) increases rapidly with the voltage up to a certain value and afterwards the rate of increase is reduced so much that the current characteristic is almost parallel to the X axis. This state continues throughout the voltage range available. The discharge current under light (i_L) in the negative light effect region showed a constant value making its characteristic parallel to the X axis. The negative light effect ($-\Delta i$) being equal to ($i_D - i_L$) follows the characteristic of the discharge current in dark (i_D).

Earlier observations of Joshi and Cherian,[1] and Khastgir and Setty[2] showed that at a constant pressure the magnitude of the photo suppression ($-\Delta i$) first increased with the voltage reaching a maximum and then diminished. But the present results do not support the above findings. The decrease of the negative light effect ($-\Delta i$) noticed in the previous investigations may perhaps be due to the effect of the atmosphere surrounding the discharge tube which in the present case has been reduced to a vacuum.

Also it may be mentioned that under the new experimental conditions there was no indication of the effect of ageing reported by earlier workers.[3-5] The discharge current as measured by the galvanometer remained practically the same whenever the readings were taken, and the light effect could be observed even when the discharge tube was kept unused for a few months.

The results of the present work appear to point to a method by which consistent results, in investigations of the light effect on A/C silent discharge current, can be obtained. Further work is in progress.

My grateful thanks are due to Prof. S. B. Bondade, for his encouragement, help and facilities. Thanks are also due to Dr. S. Ramaswamy, and to the Ministry of Scientific Research and Cultural Affairs.

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THE PHOTOLYTIC PREPARATION OF AMMONIUM-URANIUM (IV) FLUORIDE MONOHYDRATE COMPLEX

THE isolation of uranium tetrafluoride, as the product[1] of photolysis of Uranyl Salts in aqueous hydrofluoric acid medium, led us to investigate the product when ammonium bifluoride is used in place of HF. On exposure of an aqueous solution of 100 c.c. containing 3·0 gm. of uranyl

formate and 7·0 gm. of ammonium bifluoride or 3·5 gm. of uranyl nitrate, 7 gm. of ammonium bifluoride and 10 c.c. of alcohol, to sunlight for about four hours, uranium was quantitatively precipitated in the form of fine green crystals. The precipitate was filtered, washed with distilled water followed by alcohol and dried in an air-oven at 100° C., for an hour after which the analysis was carried out.

The molecular weight of the compound was determined from the U_3O_8 content of a weighed quantity of the substance. This was brought about by dissolving a known quantity of the substance in 8 N NCl and precipitating the hydrated oxide by NH_4OH and heating the precipitate, after filtration, to U_3O_8 in a platinum crucible. The filtrate was used for the estimation of fluorine as CaF_2 by the method developed by Badeeva.[2] By using Hatt's[3] method along with the Jones reductor method,[4] the entire uranium has been found to be present in the uranium (IV) state. Volumetric estimation of fluoride by modified thorium nitrate method developed in this laboratory[5] was also carried out. Ammonia content of the compound was determined by Kjeldahl's method. The analytical data establish the formula of the compound to be NH_4F, UF_4, 1 H_2O. Khlopin and Gerling[6] prepared the compound NH_4F, UF_4, 0·5 H_2O by adding NH_4F to a solution of uranium (IV) salt in aqueous hydrofluoric acid.

The expeditious removal of uranium in the form of this complex by the utilization of solar energy has been applied in this laboratory for the separation of uranium from a number of other elements. This as well as the details of the complex will be published elsewhere.

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SEPARATION AND ESTIMATION OF TOBACCO ALKALOIDS BY PAPER CHROMATOGRAPHY

THE extensive use of tobacco and tobacco alkaloids has stimulated interest in the development of micro and semi-micro methods of separation and estimation of the individual components of these alkoloids.

Separation and estimation of nicotine, nicotimine, anabasine, anatabine and nor-nicotine have been effected by two-dimensional paper chromatography from the hydrochlorides of the alkaloids. These alkaloids were obtained from tobacco extract prepared from a mixture containing equal proportions of mild and strong tobacco for smoking and tobacco leaves for chewing.

A finely ground powder of the mixture was soaked in distilled water (ratio 1 : 4 by weight), stirred periodically and filtered after 72 hours. The alkaloidal hydrochlorides, prepared by treating the extract with conc. HCl was then neutralised with excess of 6% NaOH in 60% ethyl alcohol and then mixed with $CaCO_3$. The alkaloids were then repeatedly and completely extracted with ether, till the residue no longer gave a golden yellow colour by treatment with 1·0 c.c. of cyanogen bromide and 0·2 c.c. of 2·5% analine in water solution. The ether extract was then treated with 10% HCl and the alkaloidal hydrochlorides dried under high vacuum.

Taking into view the observations of Munier and Mocheboeuf[1-4] (1949, 1950, 1951) and Carless and Woodhead[5] (1951) that the shape of the spot depended on pK, solubility of the alkaloid and on pH of the solvent, a buffered (M/10 Phosphate) Whatman No. 1 paper 40 × 40 cm. and solvent, a modification of Werle and Koch[6] (1951) consisting of *n*-butanol and acetic acid (85 : 15 v/v) for one dimension and *n*-butanol, ammonia and water (90 : 2 : 8 v/v) for the other dimension, were used. The chromatogram was run at 20° C. for 16 hours in each of the dimensions and then dried first in a stream of warm air and finally in an air-oven at 45° C. for 20 minutes.

The spots on the chromatograms were detected by the action of vapour of cyanogen bromide followed by a treatment with 0·25% benzidine solution in alcohol, and observation in ordinary and ultra-violet lights. The R_f values (see Table I) of these alkaloids were then calculated and compared with the values obtained from several control chromatograms prepared under identical conditions.

The quantitative estimation was made by elution of coloured spot and colorimetry, and the amounts of the different alkaloids were found to be higher in the strong sample of tobacco as would be seen from the table.

TABLE I

R_f values and Quantities of tobacco alkaloids in mild and strong samples

Serial No.	Name of the alkaloid	R_f value	Quantities in mg. 100 g. of sample	
			Mild tobacco	Strong tobacco
1	Anabasine	.. 0·21	22·3	26·0
2	Nicotine	.. 0·23	19·0	23·0
3	Nicotimine	.. 0·30	17·6	18·1
4	Nor-nicotine	.. 0·26	10·2	10·7
5	Anatabine	.. 0·34	15·5	16·6

The total alkaloidal content in dried mild and strong samples of tobacco was found to be 0·124 and 0·155% w/w respectively in the different samples analysed. The presence of these alkaloids was further confirmed by the preparation of picrate, methyliodide and platinichloride derivatives and by polarographic studies.

Alkaloids present in quantities below 0·5 mcg. could not be characterised. The coloured spots were close to one another on the chromatograms. The R_f values of nicotimine and anatabine showed some fluctuation, obviously due to contamination with other alkaloids.

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AN ELECTROPHORETIC STUDY OF TISSUE CULTURE FLUID FROM NORMAL AND IMMUNOGENIC LIVER CELLS IN CULTURE

ANTIBODY formation in immunised mice liver cells in tissue culture, shown by antiglobulin test and inhibition or enhancement of such antibody formation, have been reported.[1,2] The object of the present work was to study the culture fluid from immunogenic and normal cells by electrophoretic means, and see if there was any difference between the fractions from these.

The immunisation in the present experiment has been done with azo-protein, after the method described by Landsteiner and Vander Scheer.[3] The method of tissue culture, both control and experimental, and the collection of culture fluid, after 48 hours of culture, were essentially the same as described in.[1,2] For the present study a culture fluid control where the fluid did not have any explant has also been incubated and used for electrophoresis. Simultaneous runs were given with (*i*) Blank media in culture fluid control, (*ii*) Normal liver culture fluid, (*iii*) Immunised liver culture fluid and (*iv*) Normal liver culture fluid kept at − 12° C. for 48 hours. The spotting in each case was done with 0·01 c.c. of the fluid using veronal buffer 0·1 M (pH = 8·6). The electrophoresis was done at 110 volts in an Elphor paper electrophoresis apparatus. The staining of the paper was done with 0·1% bromophenol blue in ethyl alcohol saturated with mercuric chloride for half an hour, washed with 0·5% acetic acid for 20 minutes and after drying at 60° C., densitometric readings were taken in a photovolt densitometer (model 425) and the percentages of different fractions were made by planimeter.

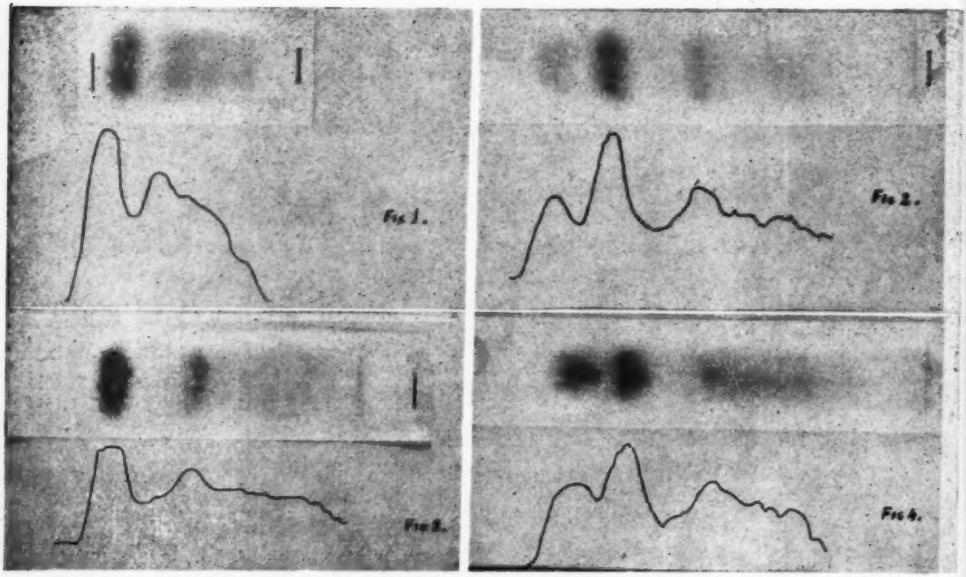
The mobility and the relative percentage of the different fractions, as determined from densitometric analysis, are shown in Table I. Figures 1-4 give photographic records of the fractions. It will be seen from Table I that both immunised and control liver culture fluid have a separate fraction having greater mobility.

TABLE I

Type of experiments	Fraction 1	Fraction 2	Fraction 3	Fraction 4
Azo protein immunised liver culture fluid	15·55%	32·04%	23·64%	28·77%
Normal liver culture fluid	20·8%	28·50%	28·20%	22·50%
Culture fluid blank	Nil	30·02%	33·11%	36·87%
Liver culture kept at − 12° C.	Nil	37·46%	31·11%	31·43%

Fraction 1 is the most mobile and fraction 4 is the least mobile.

The significant finding from these experiments is the presence of the most mobile fraction obtained from the liver cultures. This fraction



FIGS. 1–4

Fig. 1. Liver culture at −12° C. Fig. 2. Azo-protein injected mice liver culture. Fig. 3. Culture fluid. Fig. 4. Normal mice liver culture.

however is conspicuously absent from the media control and from cultures kept at − 12° C. Electrophoretic study along similar lines has mostly been directed towards finding the different fractions of the serum under different disease conditions. Key[4] pointed out the value of electrophoretic method in distinguishing the causes of ascitis. Serum proteins were electrophoretically studied by Seibert, Seibert, Atno and Campbell[5] in pulmonary diseases. Flynn[6] and Hardwick[7] have studied the electrophoretic pattern of serum in other disease conditions. Most of these studies have been directed towards finding the proportions of globulin fraction. Attention has not been focussed to the fast moving (veronal buffer pH = 8·4) fraction, which has been found in the present experiments. This fraction, although not identified properly, is likely to be a pre-albumin fraction or a protein degradation product as shown by its mobility at the said conditions. Further work is in progress.

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SOME IMPORTANT CHARACTERISTICS OF GENUINE BETEL-NUT

IN view of the widespread adulteration of betel nut, *Areca catechu*, Linn. (Palmacæ) and absence of standard for it in the Prevention of Food Adulteration Act, 1954, experiments were carried out to find some of the important characteristics of genuine betel-nut so that its adulteration with the spurious nut (*Ramsupari*) may be detected.

A number of samples of Indian and imported genuine whole betel-nut and cut piece of betel-nut adulterated with *'Ramsupari"* were procured from the local market, converted to 40 mesh

TABLE I

Sample of betel-nut	Moisture % (Average)	Per cent. on dry basis						
		Total ash	Water extract	Alcohol extract	Ether extract	Quercitannic acid	Arecoline	Areca-red
Genuine, small (Indian)	10·5	1·4–1·7	25·4–29·4	36·0–42·4	10·0–12·3	21·1–23·0	0·28–0·35	12·8–16·2
Genuine, big (Indian) ..	8·8	1·4–1·8	26·4–27·2	37·0–46·2	12·6–17·0	16·5–24·2	0·34–0·36	11·0–12·1
Genuine, Extra big (Singapur)	8·9	1·4–1·9	28·1–32·5	42·2–44·4	13·9–15·8	21·3–25·8	0·47–0·54	6·0– 6·9
Spurious nut (*Ramsupari*)	10·8	0·9–1·2	13·1–19·4	7·2–18·5	0·9– 1·5	9·5–11·2	0·02–0·04	2·0– 5·0

powder, subjected to the estimation of moisture, total ash, water extract, alcohol extract, ether extract and crude fibre by standard methods[1] and to the estimation of the volatile liquid alkaloid arecoline, $C_8H_{13}O_2N$ by the volumetric method.[2] Areca-red was estimated by extracting 1 g. of power with 100 ml. of 0·2% aqueous solution of sodium hydroxide under reflux and subsequent precipitation by dilute hydrochloric acid (1 + 2). The precipitates after filtration were washed well and dried at 100° C. to constant weight. Quercitannic acid was estimated by the standard method.[3]

The results are given in Table I.

The values of crude fibre have not been incorporated in the table as they are found to be of no significance. It is evident from the table that the bigger the nut the greater is the yield of ether extract and arecoline, whereas it is the reverse in the case of areca-red. Moreover, almost all the constituents determined here are much helpful to distinguish between genuine and spurious betel-nuts, and to fix a suitable standard for the nut.

Our thanks are due to Dr. S. K. Ghose, the Public Analyst, for facilities provided during the investigation.

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OCCURRENCE OF *AZOTOBACTER* BEIJERINCK AND *BEIJERINCKIA* DERX IN ACID SOILS OF INDIA

DURING a study of the distribution of *Beijerinckia* Derx in some fifty acid Indian soils from Assam, Tripura, West Bengal, Bihar, Madras, Kerala and Bombay, *Azotobacter chroococcum* was observed unexpectedly in a large number of soils. In the following table, the relative distribution of the organisms of both the genera in the soils studied is given:

TABLE I

Relative distribution of Azotobacter *spp. and* Beijerinckia *spp. in Indian soils*

	Per cent. of total number of soils	pH range of soils
Soils where *Azotobacter* spp. occurs	54	4·4–6·4
Soils with doubtful occurrence of *Azotobacter* spp.	22	4·2–5·8
Soils where *Beijerinckia* spp. occurs	40	4·2–6·4
Soils where both *Azotobacter* spp. and *Beijerinckia* spp. occur	26	4·4–6·0

It may be seen from the table that in India *Azotobacter* spp. is more widely distributed in acid soils than *Beijerinckia* spp. though the occurrence of the latter is believed to be favoured by acid soils.

Ordinarily, *Azotobacter* spp. rarely occurs in soil with a pH lower than 6·0 (Gainey, 1927; Burk *et al.*, 1934; Chang, 1940; Kaila, 1954). From time to time, however, isolation of acid tolerant species of *Azotobacter* has been reported (Subramoney, 1940; Maltchewsky, 1948; Tchan, 1953; Blinkov, 1955; Jensen, 1955). In this study, twenty strains of *Beijerinckia* have been isolated belonging to one species, *Beijerinckia indicum* and one variety *B. indicum*

var. *alba*. Contrary to the findings of earlier workers that occurrence of *Beijerinckia* spp. is restricted to tropics and to laterite soils alone (Kauffman and Toussaint, 1951; Tchan, 1953; Kluyver and Becking, 1955), many of the present strains have been isolated outside the tropics from soils other than laterites and lateritic formations.

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PARTIAL HYDROLYSIS OF SUBSTITUTED AMIDES OF CYANACETIC ACID BY (A) POLYPHOSPHORIC ACID AND (B) SULPHURIC ACID

Nitriles have been hydrolysed to amides by Snyder and Elson[1] using polyphosphoric acid, Sperber *et al.*[2] prepared trisubstituted acid amides from corresponding nitriles using 80% H_2SO_4 at 100° C. Thus, the substituted amides of cyanacetic acid undergoing partial hydrolysis have been converted to corresponding malon mono amides, on separately using (*a*) polyphosphoric acid and (*b*) sulphuric acid. The process is as follows:—

$$\underset{\text{I}}{CH_2\begin{matrix}CN\\CONHR\end{matrix}} \xrightarrow[(b)\ H_2SO_4]{(a)\ PPA} \underset{\text{II}}{CH_2\begin{matrix}CONH_2\\CONHR\end{matrix}}$$

(where, R is phenyl, tolyl, etc., groups).

(*a*) 0·01 M substituted cyanacetamide I, was dissolved in a clear solution of PPA, obtained by dissolving 10 gm. P_2O_5 in 6 c.c. phosphoric acid (1·75 d.) and heated for 2 hours at 110° C. The reaction mixture on pouring in water, gave white product, which was crystallised from alcohol-water and it was found to be corresponding malon mono amide II.

(*b*) 0·01 M same cyanacetamide I, was dissolved in 10 c.c. ice-cold 75% sulphuric acid and the reaction mixture was kept overnight at room temperature. It was then poured in water and white product was obtained. This, on crystallisation as above, gave the same malon mono amide II.

The yields by both methods were almost quantitative; but in (*b*) the products were more clean and this method is relatively simple. These malon mono amides II have been found identical with the authentic samples prepared by Whiteley's[3] method modified by Naik[4] and his collaborators. Further work on the above amides is in progress and details will be published elsewhere.

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DRAINAGE PATTERN ON EITHER SIDE OF ARCHAEAN-CUDDAPAH BOUNDARY

In the course of geological mapping in parts of Cuddapah Basin in Peninsular India, geomorphological studies were also made[1] with special reference to the pattern of drainage in the areas mapped. The area chosen for a detailed study of the drainage pattern lies between N. Latitude 14° and 15° and E. Longitude 77° 33′ and 78° 30′ in parts of Anantapur and Cuddapah Districts of Andhra Pradesh, in G.T.S. toposheets 57 F/9 to 16 and 57 J/1 to 8. The Archæan-Cuddapah geological boundary runs roughly N.W.–S.E. through this area for a distance of about 70 miles.

In the map covering this area, all the major intrusives such as dykes (16 in number) and brecciated quartz veins (6 in number) are marked. Table I gives the data on these intrusives.

Within the Cuddapah Basin the general attitude of the strata are noted (Table II) at various places and plotted. The dip of the

TABLE I

Regrouping of data on the attitude of the dykes and quartz veins in Archæans

Range of attitudes	Nos.
W.N.W. to N.W. ..	3
N.W. to N.N.W. ..	7
N.N.W. to N. ..	2
N. to N.N.E. ..	2
N.N.E. to N.E. ..	..
N.E. to E.N.E. ..	3
E.N.E. to E. ..	5

strata is towards north, north-east or east depending upon the strike.

TABLE II

Regrouping of data on the attitude of strata in Cuddapah Basin

Range of attitudes	Nos.
N. 1° to 10° W. ..	–
N. 11 to 20 W. ..	4
N. 21 to 30 W. ..	9
N. 31 to 40 W. ..	1
N. 41 to 50 W. ..	26
N. 51 to 60 W. ..	12
N. 61 to 70 W. ..	1
N. 71 to 80 W. ..	1
N. 81 to 90 W. ..	1
N. 41 to 50 E. ..	3
N. 71 to 80 E. ..	2

The directions of flow of almost all the streams in this area (60 each over the Archæans and the Cuddapahs) were noted separately from one inch to a mile G.T.S. toposheets (Tables III and IV). Tributaries less than four miles in length were neglected since there is a possibility that most of them might have been guided more by gradient than by structural element.

TABLE III

Regrouping of data on the directions of flow of streams over the Archæans

Direction of flow	Nos.	Direction of flow	Nos.
N. 1° to 10° E.	4	S. 61° to 70° E.	3
N. 11 to 20 E.	4	S. 81 to 90 E.	4
N. 21 to 30 E.	4		
N. 31 to 40 E.	3	S. 21 to 30 W.	1
N. 41 to 50 E.	5	S. 51 to 60 W.	1
N. 51 to 60 E.	1	S. 71 to 80 W.	1
N. 61 to 70 E.	2		
N. 71 to 80 E.	2	N. 1 to 10 W.	5
N. 81 to 90 E.	5	N. 11 to 20 W.	3
		N. 21 to 30 W.	1
S. 1 to 10 E.	1	N. 31 to 40 W.	2
S. 21 to 30 E.	1	N. 41 to 50 W.	1
S. 41 to 50 E.	1	N. 51 to 60 W.	1
S. 51 to 60 E.	2	N. 81 to 90 W.	1

TABLE IV

Regrouping of data on the directions of flow of streams over the Cuddapahs

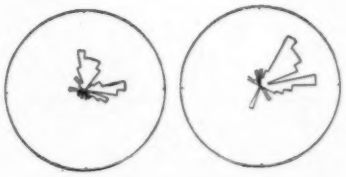
Direction of flow	Nos.	Direction of flow	Nos.
N. 1° to 10° E.	2	S. 51° to 60° E.	2
N. 11 to 20 E.	1	S. 61 to 70 E.	2
N. 21 to 30 E.	2	S. 71 to 80 E.	3
N. 31 to 40 E.	7	S. 81 to 90 E.	4
N. 41 to 50 E.	6		
N. 51 to 60 E.	6	S. 21 to 30 W.	1
N. 61 to 70 E.	5		
N. 71 to 80 E.	1	N. 11 to 20 W.	2
N. 81 to 90 E.	7	N. 31 to 40 W.	1
		N. 41 to 50 W.	1
S. 31 to 40 E.	2	N. 51 to 60 W.	2
S. 41 to 50 E.	1		

Following the pattern of graphical representation of strike and dip of joints as given by Billings,[2] the directions of the run of the dykes (16) and brecciated quartz veins (6), as well as those of the strike of the Cuddapah strata were plotted in two separate semicircles

a *b*

FIG. 1. Attitudes. (*a*) Dykes and Quartz veins; Archæans. (*b*) Strata; Cuddapahs.

(Figs. 1 *a*, 1 *b*). The directions of flow of the streams were subjected to a similar analysis and they were also plotted in two different circles (Figs. 2 *a*, 2 *b*).



a *b*

FIG. 2. Drainage. (*a*) Archæans; (*b*) Cuddapahs.

From Fig. 1 *a* it is evident that more than half of the intrusives run N.W.–S.E. and the others E.–W. with a negligibly few in other directions. Most of the streams over the Archæans (Fig. 2 *a*) are seen to flow either towards north or towards east. This might be due to certain structural elements in the granitic terrain, roughly in these directions. It was observed

in the field that there are major joints in the granites trending N.W.–S.E. and E.–W. Since the ultimate direction of slope is towards north, even those with initial direction of flow due N.W. or N.N.W. had to slowly turn towards north or north-east. It is surmised that the major joints here might have been responsible for the above directions of flow of these streams. There are numerous examples of joints having been cited as responsible for the drainage pattern in different areas.[3–5]

In the second case (Fig. 1 *b*), the strike of the rocks varies from N.W.–S.E. to W.–E. and almost all the streams are seen to flow (Fig. 2 *b*) north-east and a few to the east. To get at a better picture of the pattern of drainage in this part of the area, the attitudes of the strata nearest to streams were also noted and the nature of the stream[6] arrived at, namely, if it is a consequent, subsequent or obsequent stream. It is found that about 40 of them are consequents, about 15 subsequents and only 3 obsequents.

Thus it is seen that joints control the drainage pattern in the Archæan terrain and the attitude of strata, in the Cuddapah Basin.

My grateful thanks are due to Prof. C. Mahadevan for his interest in this work.

Geology Department, R. VAIDYANADHAN.
Andhra University,
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December 31, 1958.

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AN IMPROVED TITRATION VESSEL FOR IODOMETRIC ESTIMATION OF REDUCING SUGARS

IN the estimation of reducing sugars by the iodometric procedure,[1,2] a 25 mm. O.D. × 200 mm. tube has been suggested for titration. Such a tube with a comparatively narrow mouth has to accommodate the burette nozzle and also a stirring rod, which entails a little discomfort when several estimations are aimed at during the course of a day. An improvement in the titration tube as illustrated in Fig. 1 was found to be much more convenient for all purposes. When using such a tube the addition of sodium thiosulphate solution is done at a place slightly away from the point where the stirring operation is carried out. The advantage in

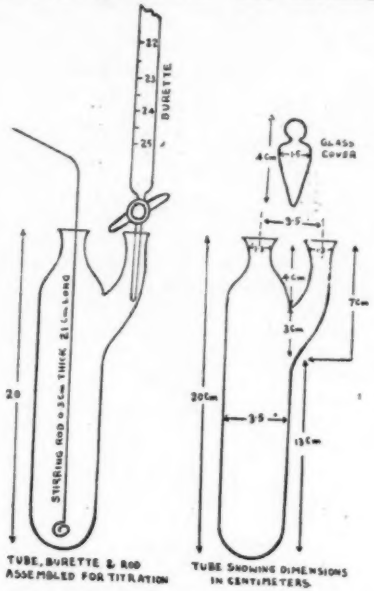

FIG. 1

using this modified tube lies in the operations of stirring and the addition of thiosulphate being carried out simultaneously. Such tubes can be prepared by using readily available material by any glass-blower.

Division of Storage and Preservation, S. D'SOUZA. W. B. DATE.
Central Food Technological Research Institute,
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ON THE APPLICATION OF FISHER'S "GOODNESS OF FIT" TEST FOR THE HOMOGENEITY OF HEAVY MINERAL ASSEMBLAGES OF THE CAUVERY RIVER SANDS NEAR TALAKAD, MYSORE

THE Cauvery river sands near Talakad, Mysore, extend over an area of 5 sq. miles. The junior author collected fourteen surface samples of these sands on a grid with sampling intervals of 50 yards. In a previous note (1958) he reported on the heavy mineral assemblages of these samples and on a qualitative basis concluded that

the sand body, despite a portion of it being affected by strong winds, shows a fairly uniform heavy mineral assemblage. This proposition viewed statistically resolves itself into the null hypothesis that "Cauvery river sands near Talakad possess a uniform proportion of the different heavy minerals, the observed differences among samples are to be attributed to fluctuations resulting from sampling of a homogeneous population". This hypothesis has now been tested by using Fisher's "Goodness of fit" test as suggested by Eisenhart (1935).

For the purposes of this test two modifications of the published percentage data (Paramasiviah, 1958) were used. (1) Reduction of the number of attributes per sample from 14 to 9 in order to satisfy the requirement of at least five observations of an attribute per cell, (2) the original raw data from which the percentages were computed rather than the percentages themselves (Eisenhart, 1935).

total counts of attributes per sample and in the last row total of an attribute over all samples are also given. From this table the grand chi-square is seen to be 202·35 which exceeds 5% and 1% points for 112 degrees of freedom. This would mean, that such a large or larger chi-square would arise less than one time in every trial of hundred, if the samples had been drawn from a population possessing a uniform proportion of the different heavy minerals. This result leads to the surmise that there are sufficient grounds to believe, as far as the present sampling scheme permits, the Cauvery sands near Talakad are quite heterogeneous in their heavy mineral assemblage. This conclusion seems to run counter to the earlier conclusions of the junior author (1958). However, a careful inspection of Table I reveals that the significant chi-square contributions for the corresponding column totals have come from opaques and amphiboles of samples A1, C2, D1, and from

TABLE I

"Goodness of fit" test for the homogeneity of the heavy mineral assemblages of the surface samples of Cauvery river sands near Talakad

Samples	Opaques	Amphiboles	Chlorite	Garnet	Pyroxene	Kyanite	Tourmaline	Epidote	Rest	Row Chi-square		No of observations per row
A1 ..	34·32*	11·05*	0·50	0·62	3·77	0·05	0·47	0·16	0·00	50·94	S.	264
A2 ..	2·93	0·53	0·20	0·36	0 90	1·14	0·07	0·50	1·45	8·08	N S.	1 9
A3 ..	2·27	0·02	1·44	0·08	0·10	1·66	0·07	1·32	0·09	7·05	N S.	2 2
A4 ..	0·24	0·60	3·70	3·60	10·12*	0·33	1·33	1·56	1·00	22·48	S.	163
B2 ..	9 45*	0·12	3·06	0·12	0·00	2·50	0·10	2·77	0·50	18·62	S.	135
B3 ..	0·61	0·00	0·70	0·09	1·12	1·80	0·07	1·40	0·35	6·14	N.S.	186
B5 ..	1·52	0·20	0·17	1·45	2·50	2·43	2·57	0·90	0·70	10·93	N.S.	189
C1 ..	0·00	0·02	0·05	0·40	0·12	0·08	0·33	0·27	0·44	1·71	N.S.	161
C2 ..	12·73*	5·00*	0·43	0·40	0·11	0·07	0·70	1·56	1·60	22·60	S.	175
C3 ..	0·08	1·40	0·57	2·57	0·08	2·90	0·23	3·68	0·08	11·50	N S	231
C4 ..	1·48	0·51	3·37	1·33	2·50	0·07	0·64	2·72	0·09	12·71	N.S.	195
D1 ..	5·76*	4·70*	0·17	0·08	0·10	0·07	0·00	0·06	0·09	11·63	N.S.	193
D2 ..	0·35	1·60	0·05	0·33	2·50	0·60	3·26	1·32	5·33*	15·34	N S.	204
D3 ..	0·90	0·20	0·73	0·00	0·40	0·30	0·07	0·53	0·40	3·53	N S	184
Column chi-square	72·24 S.	25·95 S.	15·14 N.S.	11·43 N.S.	24·32 N.S.	14·00 N.S.	9·91 N.S.	17·85 N.S.	11·51 N.S.	202·35 S.	Grand chi-square	..
No. of observations per column	188	671	328	161	135	197	193	251	152	..	..	2676 Grand sum of observations

* Significant at 5 % level for one degree of freedom.
N.S. : Non-significant at 5 % level.
S. : Significant at 5 % level.

Table I shows the computed chi-square per cell together with row, column and grand totals. For purposes of reference, in the last column, opaques only in B2, and pyroxenes only from A4. Again, examining the row totals, in case of samples A1, A4, B2, C2 their significance is

mainly due to the fact that significant contributions have come from one or two cells in a corresponding row of nine items. Following Fisher's suggestion (1945, p. 105) if the row total of the chi-squares corresponding to these samples are deleted from the grand chi-square, the latter becomes 87·71 which for 80 degrees of freedom proves non-significant at the 5% level. This may indicate that the total discrepancy between the observed and the expected frequences based on the present null hypothesis cannot therefore be regarded as quite serious. In addition, it may be also observed that Table I contains a total of 126 cells out of which 9 (indicated by asterisks) have chi-squares significant at 5% level for 1 degree of freedom. The remaining 117 have non-significant chi-squares. This may lead to the suggestion that fluctuations in opaques and amphiboles in three samples and pyroxenes in one, altogether four out of fourteen, have rendered the grand chi-square highly significant. Except for these variations the Cauvery river sands near Talakad, based on the present surface sampling scheme, appear to be homogeneous in their heavy mineral suits.

The writers are thankful to Prof. M. R. Srinivasa Rao for useful discussion and helpful suggestions.

Dept. of Geology, C. GUNDU RAO.
Central College, C. PARAMASIVIAH.
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EFFECTS OF IONISING RADIATION ON SUGARCANE BUDS

ABNORMAL leaves and bifurcations of growing shoots have been observed by several workers[1–4] in X-rayed scions of pear and apple. Granhall[2] found that growth was delayed in X-rayed scions. An increase in the colour range of stripes and differences in flowering propensity were reported by Rao[5] in plants from X-rayed buds of a striped variety of sugarcane. Tysdal[6] obtained a partially-striped sugarcane through gamma-irradiation.

Single-budded sugarcane cuttings were exposed to doses of gamma rays ranging from 10 r to 4800 r from a Co_{60} source and planted in pots, six per treatment, two per pot. In most of the treatments five buds germinated.

One of the germinated buds produced a forked stalk. Partially-dissected leaves were noticed in five of the 69 treated plants of the experiments; however, one such plant was met with among the 18 plants of the control also. In almost all cases, the affected lamina was either the 5th or the 7th from the base. In one treated plant (200 r), the 5th and 7th leaves were fused together along the midrib and along one lateral half of the sheath. In another stalk (200 r), stripes were formed on a few successive internodes and their corresponding leaf-sheaths.

The irradiation affected the growth of the plants also. At four months' age, the irradiated treatments were taller (as measured up to the topmost leaf-tip) than the control, 100 r and 800 r leading. In the first 20 days, the growth was best in the 100 r, 200 r, 400 r and 800 r and was less in the successively higher and lower treatments. In the next 40 days, the lower and medium dosage treatments 10 r to 800 r grew out comparatively faster; between 60 and 120 days, the growth of the higher doses (1200 r, 2400 r and 4800 r) was better. The main differences were reflected in the heights as measured up to the topmost transverse mark from the 50th day onwards.

The table of growth increments suggests broadly that each of the treatments underwent a period of restricted growth and that this occurred at the earliest stage in the higher doses (1200 r to 4800 r) and at a later stage in the successively lower doses. However, a broad difference in growth was noticeable between the treatments 10 r to 800 r on the one hand, and 1200 r to 4800 r on the other. In later experiments, 5 r, 6000 r and 7200 r, made definitely less growth than the controls. In the 14400 r treatment only 3 buds survived, and the growth was only half as much as in the control.

The above effects are probably due to an interference of gamma-radiation with the auxin mechanism of the buds.

Tysdal[6] has reported that sugarcane buds exposed to gamma rays of 4000 r were either killed or seriously injured. In our experiments the lethal dose was in the region of 14000 r.

The material was irradiated at the Cancer Institute (W.I.A.), Madras. The facilities and assistance so kindly afforded by Dr. S. Krishna-

murti, Scientific Director and Dr. K. S. Chandrasekharan, Chief Physicist, are gratefully acknowledged.

R. R. PANJE.
P. R. JAGDEES PRASAD.
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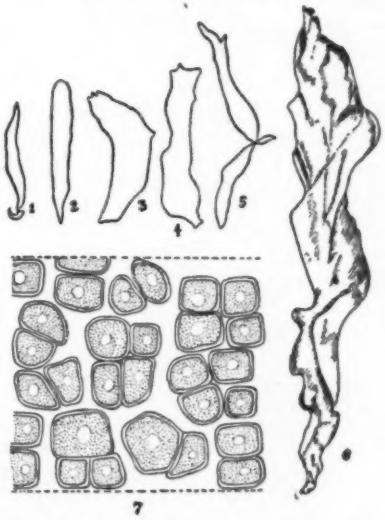
A NOTE ON THE OCCURRENCE OF *MONOSTROMA QUATERNARIUM* (KUTZ.) DESM. FROM NAINI TAL, INDIA

THE only report about the occurrence of *Monostroma* from India is by Carter,[1] who collected it from the cold snow water of Trisuli River in 1926. The authors collected this alga in September 1956 from a cold water stream situated at a distance of two furlongs down St. Loo barrier on Ratighat Road in Naini Tal. Subsequently the alga was collected in early September this year from a fast flowing stream on the same road near Doonikhal.

This alga was found growing abundantly in small clusters attached to small stones and pebbles. It is short lived (about 2-3 months) and disappears quickly with the drying up of the streams. The thalli are dark-green in colour and are found attached to the substratum by small rhizoidal outgrowths. They are usually in the form of expanded sheets (Figs. 1-6) and measure up to 8 cm. in length 2-2·5 cm. in width. The thalli are found variously crumpled (Fig. 6) perhaps due to the impact of swift water currents. They are usually narrower towards the ends and broader towards the centre. The cells exhibit a parenchymatous structure in surface view (Fig. 7). They are somewhat angular, occurring in groups of 2-4 and are separated from each other by intervening gelatinous material. In cross-section they are somewhat semicircular to oval and measure 11·9-17 μ high. Cells are uninucleate and contain a single parietal laminate chloroplast (Fig. 7) which encircles the greater part of the cell. Each cell contains a single pyrenoid.



Figs. 1–6. Showing thalli of various shapes and sizes. Note the crumpling of thallus in Fig. 6 (About natural size).

Fig. 7. A portion of the thallus, showing the arrangement of cells in surface view, ×1,300.

The present alga resembles *Monostroma quaternarium*[2] in the morphology of the frond and vegetative cells, except with slight variations in their average cell measurements.

Department of Botany, K. P. SINGH.
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Naini Tal,
October 17, 1958.

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A NEW SPECIES OF *OIDIUM* ON *RAUWOLFIA SERPENTINA*

THE author encountered a large-scale infection of mildew on *Rauwolfia serpentina* Benth. ex Kurz. grown in the green-house of the Morris Arboretum, Philadelphia. It is of considerable interest that even though several species of the genus *Rauwolfia* L., were housed in the same green-house, *R. serpentina* alone was prone to the mildew infection caused by a new species of *Oidium* which has not been so far reported.

This disease is of great economic importance as *R. serpentina* is fast developing into a plantation crop.

The *Oidium* species is described below:

Oidium rauwolfi Varadarajan (spec. nov.)

Mycelium superficial creeping, hyaline, septate and branched, 4·5–6·0 μ in diameter forming a mat on the upper surface of affected leaves; haustoria lobed and irregular in shape; conidiophores erect, simple and usually 2–3 septate; conidia unicellular, elliptical, oblong, obtuse and hyaline measuring 25·5–34·5 μ in length and 13·5–19·5 μ in width and borne singly.

Oidium rauwolfiæ Varadarajan (spec. nov)

Mycelium superficiale, reptans, hyalinum, septatum, ramosum, 4·5–6·0 μ diameter, efformans tegeticulam in superiore pagina foliorum infectorum; haustoria lobata et irregularia forma; conidiophori erecti, simplices et ut plurimum bis vel ter septati; conidia unicellularia, elliptica, oblonga, obtusa et hyalina, 25·5–34·5 μ longa, et 13·5–19·5 μ lata singulariter insita.

HABITAT

On the leaves of *Rauwolfia serpentina* Benth. ex. Kurz. grown in the green-house of the Morris Arboretum, Philadelphia. The type was deposited at the Morris Arboretum, Philadelphia, Pa, U.S.A.

THE DISEASE

The mildew was first observed as faint, circular and whitish areas of minutely radiating hyphæ on the upper surface of normal leaves of the host. It may be stated here that at the time of the infection, the green-house was overcrowded with plants, the humidity high and the range of temperature between 70–90° F. All factors, probably, contributed to the rapid spread of the infection.

Sooner, the faint fungal areas on the affected leaves became prominent and several of them coalesced to form a cottony covering over the entire leaf surface. As the severity of the infection increased the diseased leaves started curling upward, rapidly lost the chlorophyll pigment and were finally shed. An examination of the affected leaves revealed that the hyphæ of the pathogen have penetrated only the epidermal tissue of the host and the infected cells had disorganised contents, while the entire chlorenchymatous tissue turned yellowish owing to a general disintegration of the chloroplastids.

CONTROL

Affected plants were segregated and severely infected leaves were removed. Weekly dusting of sulphur for 6 weeks brought the disease under control, while a general dusting of sulphur in the green-house prevented any further spread of the disease.

The author wishes to express his grateful thanks to Prof. Dr. John M. Fogg Jr., Director, The Morris Arboretum, Philadelphia, Pa, U.S.A., for his valuable advice and helpful criticism in the preparation of this paper and to Olin Mathieson Chemical Corpn., New York, for the award of a research grant. Thanks are due to Rev. Fr. H. Santapau, St. Xavier's College, Bombay, for Latin diagnosis of the new species described.

The Morris Arboretum, P. D. VARADARAJAN.*
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CHROMOSOME NUMBERS IN SOME COMMON FLOWERING PLANTS

THE chromosome numbers in the following plants were determined from the study of the pollen mother cells. Anthers from young flower buds were fixed in acetic alcohol solution 3 : 1 and examined in propiono carmine.

The observations were made from temporary preparations.

TABLE I

Sl. No.	Name of the plant	Family	Number of chromosomes (Haploid number)
1	*Acalypha indica* L. ..	Euphorbiaceæ	14
2	*Asperagus racemosus* Willd.	Liliaceæ	30
3	*Hibiscus rosasinensis* L.	Malvacæ	18
4	*Ipomæa festigridis* L	Convolvulaceæ	15
5	*Ipomæa pentaphylla* Jacq.	do.	15
6	*Mucuna monosperma* DC.	Papilionaceæ	11
7	*Parthenium hysterophorus* L.	Compositæ	18
8	*Punica granatum* L. ..	Punicaceæ	8
9	*Rhynchosia auria* L. ..	Papilionaceæ	11
10	*Rhynchosia himalensis* Benth.	do.	11

The chromosome number of *P. granatum* is $n = 8$ (Tjio, 1948), $2n = 18$, 19 (Kostaff *et al.*, 1935) and $n = 9$ (Proos, 1938) (as given by Darlington and Wylie, 1955). The chromosome number in common pomegranate grown around Poona has been found to be $n = 8$.

The chromosome number in red, single corolla type shoe flower (*H. rosasinensis*) was observed to be $n = 18$. This number appears to be very low when compared with the previous records by Skovested (1935) as $n = 92$, Youngman (1927) as $n = 144$ and Skovested (1941) as $n = 168$.

To the best of the knowledge of the author, the chromosome numbers reported herein, except that of *P. granatum*, are new records.

Cytology Laboratory, M. V. THOMBRE.
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REDUCTION IN THE INTENSITY OF CHLOROSIS ON MANDARIN PLANTS (*CITRUS RETICULATA* SWINGLE)

SYMPTOMS of zinc deficiency in citrus trees have been described by Batchelor and Webber (1948), Camp, Chapman and Parker (1949), Smith and Reuther (1954) and Dikshit (1958 *a*). Symptoms of chlorosis and drying of young shoots on seedling mandarin plants have been reported by Dikshit (1958 *b*). He also has reported reduction in the intensity of chlorosis on two-year old citrus plants following sprays with zinc sulphate. Mukherjee (1949) has reported deficiency of zinc and manganese from soils in Coorg. The present note embodies the results of sprays with proprietary fungicides containing diethyldithiocarbamates of zinc and iron on ten-year old seedling mandarin trees. These compounds (Triscabol and Trifungol) have been tried with good results by Teitsma and Hadividjaja in Indonesia.

Ten-year old severely affected plants, which were comparable in vigour, were selected for the study. Five plants were sprayed with Triscabol + Trifungol (34 gm. + 17 gm. per four gallons of water), the plants receiving six sprays from July to December 1957, at monthly intervals. Another set of five trees was treated as control and did not receive the sprays. All the ten trees received identical fertiliser treatments, *viz.*, one pound of nitrogen as ammonium sulphate, half pound of phosphorous as superphosphate and half pound of potash as muriate of potash. Intensity of chlorosis was determined by classifying the trees in 0, 1, 2 and 3 grades depending upon the increasing severity of the symptoms, healthy plants being put in grade 0 and the maximum affected ones in grade 3. Separate scoring was done in respect of the younger leaves which were situated towards the periphery and the older ones which were located towards the main stem. A plant which had most of the new and old shoots showing chlorosis thus scored 6 marks. This was considered to be equivalent to 100% intensity on the plant. The observations were continued for a period of 12 months, 6 months during which the sprays were being given and another six months after the sprays were discontinued. Thus a fairly representative picture of the response could be obtained by the figures available. Percentages of intensity of chlorosis per plant from August 1957 to July 1958 are given in Table I.

Figures given in Table I indicate a reduction in the intensity of chlorosis on the sprayed plants. The present finding with ten-year old plants confirms the trends reported earlier with two-year old seedlings. In a number of observational spray trials, conducted on ten-year old plants, with zinc, manganese, iron and copper, consistent positive response was obtained with zinc sprays only. In none of the cases, however, could complete recovery be effected. The incomplete recovery of the plants may be due to co-existent deficiency of some other micro or macro-element along with that of zinc.

Well-marked periodic variations in the intensity of chlorosis during different months irrespective of the spray treatment are another

TABLE I

Showing intensity of chlorosis per plant on sprayed and unsprayed plants during different months

Treatment	1957					1958							Mean
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	
Sprayed	.. 66·0	26·0	40·0	33·0	26·0	20·0	23·0	23·0	0·0	30·0	36·6	26·6	29·2
Unsprayed	..100·0	53·3	53·3	80·0	76·7	73·0	60·0	70·0	10·0	56·0	80·0	63·3	64·6

interesting feature of this study. In the present instance intensity of chlorosis came down to 26% per tree on the sprayed plants in the third month after the commencement of observations. A similar reduction was observed on the unsprayed plants also but they had comparatively higher intensity (53%) during the corresponding month. Again the intensity on sprayed plants fluctuated between 20 and 40% while on the unsprayed plants it was 53 and 80%. Total absence of symptoms on the sprayed plants during the month of April, and a very well-marked reduction in intensity on unsprayed plants during that month are features which are being investigated further.

I thank Dr. R. D. Asana for kindly suggesting this line of approach and giving the chemicals for trial, and Dr. K. M. Aiyappa for his interest in the work. Warm thanks are also due to Sri. M. C. Mathew and Sri. M. Abraham, Manager and Superintendent respectively, who permitted this observational trial at their Huvinkadu Estate, and provided facilities for spraying and other field operations.

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BLUE MOLD OF AMLA (*PHYLLANTHUS EMBLICA* L.)*

IT was found that Amla fruits, in storage rooms and market places in Banaras, were affected by a species of *Penicillium*, which so far as the author is aware, has not been described before.

The rot is characterised by brown patches with water-soaked areas surrounding a wound which soon increases in size assuming a light brown colour and becomes quite soft and sunken. As the rot progresses, three distinct colour zones of bright yellow, purple brown followed by a bluish green conidial mass from the centre of the rotten portion spreading gradually to the whole fruit can be clearly observed with the exudation of drops of yellowish liquid on the fruit with a bad odour. The whole fruit finally gives a bluish green pustuled or beaded appearance.

A microscopic examination of the rotted portion showed fungal hyphæ from which arise, funiculose hyphæ bearing conidiophores (50-75 μ) which produce a terminal symmetrical verticil of usually several metulæ 4-6 in number (8-10 $\times$ 2-2·8 μ) bearing symmetrical verticil of sterigmata. Sterigmata are shorter and parallel, closely packed in clusters, 5-8 in number (7-9 $\times$ 1·8-2·2 μ). Conidia are elliptical to globose (3-3·5 $\times$ 2·5-3 μ), smooth and borne in short chains. A symmetrically biverticillate penicillus is the characteristic feature of the organism and it is identified as *Penicillium islandicum* Sopp. (Raper and Thom, 1949).

The following control measures have been found to be useful in arresting the fruit rot: (*a*) careful handling of the fruits to avoid injuries through which natural infection takes place, (*b*) securing sanitary conditions in the storage rooms by gas treatment of NCl_3 and Ozone with good ventilation and (*c*) treatment of fruits with mild antiseptics like borax and sodium chloride in very dilute concentrations.

My thanks are due to Prof. A. Lal, College of Agriculture, Banaras Hindu University, for guidance and interest in the course of the present work.

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December 10, 1958.

* Part of the thesis submitted for M.Sc. (Ag.), at Banaras Hindu University, Banaras.

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INHERITANCE OF FOURTH GLUME IN CERTAIN *SACCHARUM* HYBRIDS

SEGREGATIONS in sugarcane crosses are not easy to explain on account of the cytogenetical complexities of the plant as also the mode of gamete and zygote formation in the parents. There is a wide range of variation in the F_1 seedlings of any cross or even in the selfed progeny of any single variety.

The present note relates to a finding made with regard to the inheritance of the Fourth Glume in the intergeneric crosses between the two species

TABLE I

Showing the number of seedlings examined in different crosses

Sl. No.	Cross				No. of seedlings studied
1	*S. officinarum* var. Vellai	(2n=80)	×	*Sclerostachya fusca* (2n=30)	13
2	do. Lakhapur	(2n=80)	×	do. do.	7
3	do. Zw. Cheribon	(2n=80)	×	do. do.	3
4	do. K. Boothan	(2n=80)	×	do. do.	4
5	do. Chittan	(2n=80)	×	do. do.	14
6	do. Manjri Red	(2n=80)	×	do. do.	62
7	do. Kajla	(2n=68)	×	do. do.	112
8	do. Vellai	(2n=80)	×	*Narenga* do.	2
9	do. Zw. Cheribon	(2n=80)	×	do. do.	1
10	do. K. Boothan	(2n=80)	×	do. do.	1
11	do. Chittan	(2n=80)	×	do. do.	3
12	do. Kajla	(2n=68)	×	do. do.	65
13	*S. robustum* S.H. 598 (28 N.G. 251)	(2n=84)	×	*Sclerostachya* do.	66
14	*Sclerostachya fusca*	(2n=30)	×	*S. robustum* S.H. 598 (28 N.G. 251) (2n=84)	6
15	*S. robustum* S.H. 598 (28 N.G. 251)	(2n=84)	×	*Narenga* (2n=30)	22
16	*S. officinarum* var. Manjri Red	(2n=80)	×	*Erianthus ciliares* (2n=40)	14

of *Saccharum, viz., S. officinarum and S. robustum* on the one hand and the allied genera, *viz., Narenga, Sclerostachya* and *Erianthus* on the other. Most of the varieties belonging to the two species mentioned above are characterised by the absence of the Fourth Glume, as distinct from other species of *Sacharum, viz., S. barberi, S. sinense* and *S. spontaneum* and also the allied genera, *Narenga, Sclerostachya* and *Erianthus* in which the Fourth Glume is always present. Seedlings from a large number of crosses were examined for this character as detailed in Table I.

A study of the Floral Morphology of the F_1 populations listed in Table I showed the presence of the Fourth Glume in all the crosses. It may be mentioned that the Fourth Glume is also similarly transmitted in the interspecific cross between *S. officinarum* and *S. spontaneum*. The presence of the Fourth Glume in the F_1 seedlings in all the above-mentioned crosses indicates that it is dominant in inheritance and offers a valuable criterion for determining the genuineness or otherwise of certain *Saccharum* crosses.

The authors take this opportunity to express their deep sense of gratitude to Dr. N. R. Bhat, Director, Sugarcane Breeding Institute, Coimbatore, for valuable suggestions and keen interest.

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December 13, 1958.

PUCCINIA ERIANTHI, PADW. AND KHAN ON CULTIVATED SUGARCANE

RUST on *Saccharum, Puccinia kuehnii* (Kr.) Butl. has been recorded on *S. spontaneum* by Butler.[2] Only two species, namely, *P. kuehnii* (Kr.) Butl. and *P. erianthi*, Padw. and Khan,[6] were known to occur in India. Patel *et al.*[7] observed this disease on a cultivated variety Co. 475 in Bombay State and identified it as a new species, *P. sacchari*. Chona and Munjal,[4] however, identified the rust on Co. 475 obtained from the same area as *P. kuehnii* (Kr.) Butl. The rust found on the cultivated variety, *viz.*, Co. 876 was also reported as *P. kuehnii* (Kr.) Butl. by Chenulu[3] and Srinivasan[8] respectively.

During November 1958, rust was collected on two sugarcane varieties, namely, Co. 1191 and Co. 1243 from the varietal collections at the East India Distilleries and Sugar Factories, Nellikuppam and from Co. 1243 at the Sugarcane Research Station, Cuddalore.

The rust on Co. 1191 occurs on the leaves only. The most important features of the urediospores are as follows :—uredia hypophyllous, sometimes amphigenous, sub-epidermal, urediospores ovoid to pear-shaped, thick-walled, uniformly thickened all round, rarely slightly more thickened at the apex, echinulate, with 3-4 large distinct pores (Fig. 1), generally 4, either equatorial or scattered, measuring 20·85–39·62 μ (27·11–33·36 μ) in length by 16·68–27·11 μ (18·77–25·02 μ) in width, paraphyses in uredia capitate, on long stalks, thick-walled, pale to brick colour.

Telia occur on the undersurface of the leaf, sometimes on the upper surface also, sub-epidermal, teleutospores (Fig. 2) two-celled, smooth-walled, not uniformly thick, always more

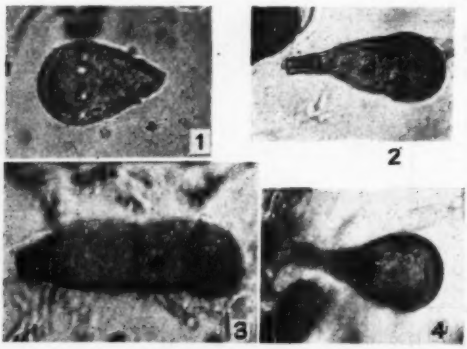

FIG. 1. The urediospore with 4 distinct germ pores. FIG. 2. The normal two-celled teleutospore. FIG. 3. The abnormal 3-celled teleutospore. FIG. 4. The abnormal 1 celled teleutospore.

thickened at the apex, clavate, the apical cell usually rounded, the lower one elongated, slightly broad above and narrowed below with a slight constriction at the septum, the length of the stalk ranging from 6·24–25·02 μ (usually 10·4–12·5 μ). The teleutospores occur in large numbers ranging from 33·36–52·13 μ (37·53–50·04 μ) in length by 16·68–29·19 μ (18·77–25·02 μ) in width.

In this sample, certain abnormalities of teleutospores were observed. Some spores were distorted in shape. Three-celled (Fig. 3) and one-celled (Fig. 4) teleutospores were rarely met with. Such aberrations are not uncommon in the species of *Puccinia* and it was thought as a teratological feature by earlier workers.[1,5]

The urediospores of the rust on Co. 1243 collected at Nellikuppam and Cuddalore measure 20·85–39·62 μ (27·11–33·36 μ) in length by 16·68–29·19 μ (18·77–22·94 μ) in width and the teleutospores 33·36–52·13 μ (37·53–50·04 μ) in length by 16·68–25·02 μ (18·77–22·94 μ) in width, almost the same size as that found on Co. 1191. In other characters, this rust resembles that on Co. 1191. The abnormal 3-celled and 1-celled teleutospores were observed in this case also.

The rust on Co. 1191 and Co. 1243 differs from the one on *S. spontaneum*, *P. kuehnii* (Kr.) Butl. described by Butler[2] and Srinivasan and Chenulu[8] in a number of important characters as mentioned in Table I.

The rust observed on Co. 1191 and Co. 1243 has a close resemblance to *P. erianthi*, Padw. and Khan and hence is identified as such. Further studies are in progress.

We are highly grateful to Dr. N. R. Bhat, Ph.D. (Cantab.), Director, Sugarcane Breeding Institute, Coimbatore, for his keen interest and encouragement. Our thanks are also due to Dr. K. Ramakrishnan, Government Mycologist, Agricultural College, Coimbatore, for his valuable suggestions.

TABLE I

Sl No.	Characters	Rust on Co. 1191 and Co. 1243	Rust on *S. spontaneum* *P. kuehnii* (Kr.) Butl.	*P. erianthi*, Padw. & Khan
1	Size of urediospores ..	27·11–33·36×18·77–22·94 μ	19–57×18–34·5 μ	24·1–34·9×18·1–25·3 μ
2	Apical thickening of the urediospores	Almost uniformly thick all round, rarely slightly thickened at the apex	Pronounced apical thickening	Slightly thickened at the apex
3	Germ pores ..	3 or 4, usually 4 distinct pores, either equatorial or scattered	3–5, equatorial	4, large distinct pores, equatorial or scattered
4	Occurrence of teleutospores	Occur abundantly	Generally absent, if present scanty and immature	Present
5	Size of teleutospores ..	37·53–50·04×18·77–25·02 μ	25–40×10–18 μ	28·9–45·8×14·5–21·7 μ,
6	Colour of the spores ..	Pale to brick colour or Kaiser brown (Kidgway)	Yellow	Pale to brick colour

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December 20, 1958.

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ROOT AND NODULE DEVELOPMENT IN *DOLICHOS LABLAB* L. INFECTED WITH DOLICHOS ENATION MOSAIC VIRUS

DOLICHOS enation mosaic virus, first reported in India by Capoor and Varma,[1] infects a large number of leguminous plants producing characteristic enations besides mottling and laminar suppression. In an attempt to study the effect of the virus infection on the subterranean parts of *Dolichos lablab* L., it was found that in fully infected plants the root system was poorly developed and the number of root nodules surprisingly reduced (Fig. 1).

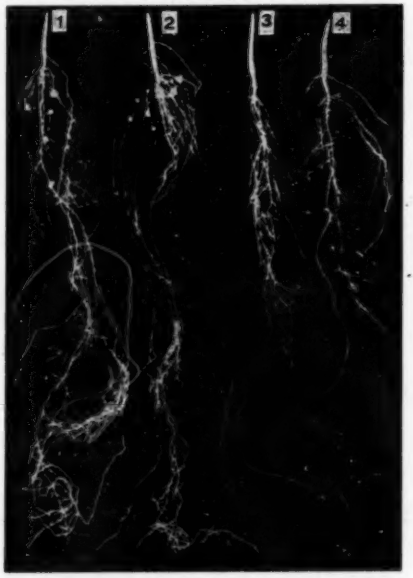

FIG. 1. Effect of Dolichos enation mosaic virus on the root system of *Dolichos lablab*.
1 and 2—Control.
3 and 4—Infected (note the suppression of root nodules).

The intensity of these symptoms appears to be directly related to the severity of infection.

Seeds of *Dolichos lablab* (variety DL 231) obtained from the Agricultural College, Coimbatore, were sown in garden soil in large clay pots and when the first pair of the foliage appeared, they were inoculated with a standard extract of inoculum of Dolichos enation mosaic virus (1 g. of young infected leaves of *Dolichos lablab* ground in 1 ml. of glass-distilled water) using 500-mesh carborundum powder as an abrasive. One set of uninoculated plants served as the control. After about a month of inoculation the healthy and infected plants were carefully lifted out without damaging the root system for examination.

Bakshi and Singh[2] have reported a reduction of root nodules in shisham (*Dalbergia sissoo* Roxb.) infected with *Fusarium solani*. Similarly, *Cajanus cajan* infected with *Fusarium udum* has been shown in this laboratory to contain poorly developed nodules (Subramanian, unpublished). The poor development of the root system may be attributed to a low auxin content of the roots as reported in the case of 'potato degeneration' diseases.[3,4] It, however, remains an open question whether the reduction in root nodules is due to deranged metabolism of the infected host resulting in the formation of inhibitors/products not conducive to the formation of the nodules. The direct action of the virus on the nodule organism and the modified morphology of the root tissues[5] preventing the hypertrophy for formation of the nodule, can also be hardly ruled out. Further studies are under way.

The author is indebted to Prof. T. S. Sadasivan, Director, University Botany Laboratory, Madras, for encouragement and suggestions.

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TUBERCULINA—HYPERPARASITE OF *AECIDIUM AMARYLLIDIS* SYD. AND BUTLER

Aecidium amaryllidis Syd. & Butler has been found to occur for the last two years during the rainy season (August, September) on the leaves of *Crinum asiaticum* growing in the Public Gardens and Karkhana Bag, Kota. In the month of September 1958, the æcia were found covered with a whitish grey fungal coating. In the transverse sections, the hyperparasite in the æcia showed purple colour with smooth sporodochia. Aeciospores and basal cells were found in a process of disintegration. In later stages, the disintegration of the æcial plectenchyma has been followed by the development of sporodochia. In cases of the attacked developing æcium, the development of æciospores does not take place

and the æcium is completely occupied by the hyperparasite. The conidiophores are simple, non-septate, hyaline and bear single-celled, hyaline, spherical, smooth, thin-walled, single conidia acrogenously. The spores measures 7·2 to 9·0 μ.

The uridinicolous nature of the fungus with smooth sporodochia, hyaline mycelium and conidia confirm it to belong to the genus *Tuberculina* Sacc. To the best of the knowledge of the authors the hyperparasite has not been recorded so far, on *Aecidium amaryllidis* Syd. & Butler. *T. persicina* (Ditm.) Sacc. has been found to occur on æcidia of *Aecidium euphorbiæ*,[1] *Puccinia arrhenatheri* and *Aecidium rhamni*[4] and *T. vinosa* on those of *P. poarum*.[1]

In India, two species of *Tuberculina*—*T. costaricana* Syd. parasitizing æcia and pycnia of *Uromyces hobsoni* Vize.[3] and *T. persicina* on the æcia of *Aecidium pavettæ* Berk. and *Aecidium* sp. on *Strobilanthes cuspidatum* T. And[2]—have been reported.

On the basis of the morphological characters of the fungus, the shape and the size of the conidia, it is identified to be *T. costaricana* Syd. It is the first record of the hyperparasite on this host.

Sincere thanks are due to Dr. N. Prasad, Plant Pathologist, Rajasthan, for keen interest and encouragement and to Shri Samarth Raj, Director of Agriculture, Rajasthan, for facilities.

Plant Pathology Section, Dept. of Agriculture, Rajasthan, Udaipur,
November 24, 1958.

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J. P. Agnihotri.

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OCCURRENCE OF A MICROSPORIDIAN (PROTOZOA) PARASITE IN FRESH-WATER OLIGOCHAETES

While studying the freshwater oligochætes *Pristina longiseta longiseta* and *Nais communis*, belonging to the family Naididæ, from the vicinity of Cuddapah, Andhra Pradesh, South India, sporocysts of the microsporidian *Mrazekia caudata* Leger and Hesse, 1916, were found in the cœlom of the middle region of four worms. This parasite was hitherto known only from the members of the family Tubificidæ. Different stages of development of the sporocysts were observed: small colourless cysts without spores, medium cysts of translucent, greenish gray colour with minute unripe spores, and large, opaque, dark gray cysts containing hundreds of closely packed ripe spores. The ripe spores are liberated by rupture of the sporocyst wall into the host cœlom, where they escape by death and disintegration of the host or probably by way of nephridia. The presence of several sporocysts in one worm proves fatal. The ripe spore (Fig. 1) measures 23-27 μ in length and 1·5 μ in width, hence is longer than the original description. It has a cylindrical body containing a nucleus and a pointed caudal end.

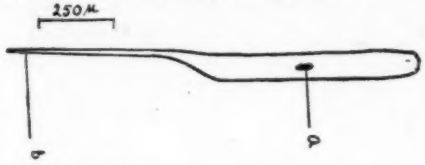

FIG. 1. *Mrazekia caudata*: ripe spore. *a*, nucleus; *b*, caudal end.

This is the first finding of the microsporid parasite in Asia.

I thank Dr. L. H. Hyman of the American Museum of Natural History, New York, for her help in the preparation of this note.

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AN INEXPENSIVE TAG FOR MARKING HILSA

One of the major difficulties encountered in undertaking large-scale marking experiments to study the migrations and population dynamics of fishes in India has been the non-availability of suitable tags locally at reasonable cost. Efforts were therefore made to hand-fabricate inexpensive tags in this Research Station. A type of nylon streamer tag thus developed and found quite suitable for marking Hilsa is described here. The cost of the tag works out to less than a rupee per hundred.

The tag (Fig. 1) consists of a rectangular strip of yellow or red soft upholsterer's vinyl plastic, 35 mm. × 12 mm. and about 0·2 mm. thick. One end of the plastic strip is rounded and a hole is punched at the other. The necessary legend and serial number are written on either side of the tag with an artist's pen, or are stamped on with rubber stamps. This is done with Vinyl

Stamping Black Ink 104N5A4 manufactured by the California Ink Company, U.S.A. Before writing the legend the tag is cleaned with a piece of cloth soaked in acetone in order to remove the glaze and any extraneous matter that might prevent the ink biting into the

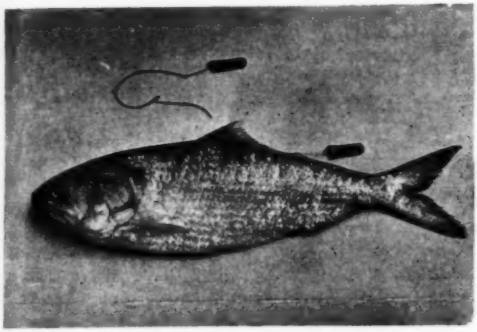

FIG. 1. Photograph of a tagged Hilsa. A tag with the needle is shown above it.

plastic. About 35 cm. of braided nylon thread is doubled and the free ends are drawn through the punched hole and tied over the rolled-up end of the plastic strip to prevent its tearing off when pulled. First a box knot is tied and this is reinforced by a reef knot. The two free ends of the thread are then sealed together by holding them over a candle flame with a pair of small pointed forceps. The necessity for rolling the end of the tag can be avoided if a light plastic eyelet is fixed in the punched hole. Another guard knot may be tied on the nylon streamer about 25 mm. above the tag to prevent the knot from slipping when the tag is finally tied to the fish.

For marking Hilsa, the tag is tied on the dorsal side of the fish. Immediately after capture the live fish is placed in a specially constructed "cradle" lined with plastic foam sheeting, which is kept immersed in water. The nylon thread is passed through the dorsal musculature of the fish immediately behind the dorsal fin (Fig. 1) with the help of a surgeon's needle, about 7 cm. long, having a bent end. A knot is then tied below the guard knot on the length of the streamer, which will prevent the loop from tightening itself on the body of the fish. During the last Hilsa fishing season over 750 Hilsa were tagged with this type of tag and the recovery so far is about 8%. The recovered fish were all in good condition and the tags were easily recognised by the fishermen. The size of the tag allows fairly explanatory legend which can be written in any language as required, and this helps the recovery considerably. The longest period of submersion observed by us so far is nine months and this has had hardly any effect on the tag.

Central Inland Fisheries Research Station, Calcutta-9, *January* 9, 1959. T. V. R. PILLAY.

A NOTE ON THE CHEMICAL EXAMINATION OF THE CONSTITUENTS OF THE BARK OF *FERONIA ELEPHANTUM*

FROM the alcoholic extract of the bark of *Feronia elephantum* (natural order Rutaceæ), two compounds having the molecular formulæ $C_{29}H_{40}O_9$ and $C_{18}H_{34}O_3$ have been isolated in the pure form. The compound $C_{29}H_{40}O_9$ melts at 176-77° C., is soluble in ethanol, methanol and pyridine but insoluble in water, petroleum ether, ether, benzene, chloroform and ethyl acetate. It does not react with sodium bicarbonate but dissolves in sodium hydroxide solution producing a deep yellow coloured solution from which the original compound can be precipitated back by the addition of mineral acids. The compound gives a dirty green colour with ethanolic ferric chloride and forms an acetyl derivative and a benzoyl derivative. The molecular weight of the compound could not be determined by the cryoscopic or the ebullioscopic method because of its insolubility in suitable solvents, nor could it be determined by the Rast method because of its immiscibility with camphor. The molecular weight of the benzoyl derivative was, however, determined by the Rast method and from the results of the elementary analysis and molecular weight of the benzoyl derivative, the molecular weight of the original compound was computed. As a result of these the compound has been found to contain six hydroxyl groups. The presence of one methoxyl group in the compound has been established by the Zeisel's method. The compound formed a 2 : 4-dinitro-phenylhydrazone which was found to contain 7·56% of nitrogen, corresponding to the presence of one ketonic group.

As a result of the study of the I.R. absorption spectra of the compound, the presence of the following groups is indicated :—an unconjugated C = O group (peak at 5·832 mμ), a —C = C— unconjugated unsaturation (peak at 6·065 mμ), phenyl ring (peaks at 6·121 and 6·650 mμ), a

methyl ketone (peak at 6·854 mμ), a C-methyl group (peak at 7·272 mμ), a methoxyl group (peak at 7·519 mμ), Ar-O-CH_3 group (peak at 7·968 mμ), a $-\overset{CH_3}{\underset{|}{CH}}-\overset{CH_3}{\underset{|}{CH}}-$ linkage (peaks at 8·906 and 9·091 mμ) and a 1 : 3 : 5—trisubstituted benzene ring (peak at 12·15 mμ). The detailed study of the structure of this compound and its degradation products is in progress.

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TOLBUTAMIDE AND PANCREATIC ACTIVITY OF GUINEA-PIGS

"TOLBUTAMIDE" (1-butyl-3-p-tolysulphonylurea) has now been well established as a suitable orally effective hypoglycemic agent for diabetic patients with the "maturity onset" type of diabetes mellitus.[1] In spite of various investigations by different workers, the precise mechanism of action of such sulphonylureas remains unknown.

Holt, Kracht and others have demonstrated[2-4] increased β-cell activity in normal animals on administration of "Tolbutamide". Campbell's[5] experiments suggest a sparing action of Tolbutamide on the insulin secreting mechanism. Definite information is not yet available on the direct or indirect effects of Tolbutamide on the histological changes brought about in the α, β and the acinar cells, on prolonged administration of the drug to normal animals. Preliminary results obtained in one of a series of experiments on the pancreatic activity of guinea-pigs in response to prolonged daily administration (oral) of Tolbutamide are indicated in the present communication.

Groups of normal healthy guinea-pigs were administered 'Tolbutamide' powder[6] orally, in a daily dose of 100 mg./kg. The pancreatic amylase content of these animals and the biological potency of their pancreatic insulin were determined at regular intervals by using standard methods.[7,8] The results are given in Table I.

The animals getting Tolbutamide showed no signs of any toxicity and maintained excellent health. The overall increase in body weight in sixty days in the Tolbutamide fed group was found to be 17·28% higher than their litter mates in the control group.

TABLE I

Effect of Tolbutamide Feeding on the Amylase and insulin content of the pancreases of guinea-pigs (Average figures)

Groups	No. of animals	Days of Tolbutamide feeding	Pancreatic amylase (mg. of maltose gm. of dry pancreas)	Pancreatic insulin potency by rabbit assay method (% reduction/gm. of pancreas)
I	4	0 (control)	654·10	14·72
II	4	43	1688·00	15·53
III	4	59	1756·00	..
IV	4	64	2672·00	42·14

It is evident from Table I that both insulin potency as well as pancreatic amylolytic activity increases gradually with prolonged feeding of Tolbutamide in guinea-pigs. The increase in insulin potency may be interpreted to be due to an increased secretory activity of the β-cells or a suppression of activity of the α-cells or both; whereas the significant simultaneous increase of the amylolytic activity/gm. of tissue may be due to an increased proteosynthetic activity of the acinar cells.

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Birla College, Pilani, MAHENDRA KUMAR.
November 22, 1958.

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5. Campbell, J., *Can. Med. Assoc. J.*, **1956**, **74**, 962.
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7. Hawk, *Pract. Physiol. Chemistry*, Pub: J. and A. Churchill, London, 1954, p. 401.
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   (*b*) Burn, *Biological Standardizations*, Oxford Medical Publication, London, **1952**, p. **196**.

REVIEWS

DOVER BOOKS

Statics and Dynamics of a Particle. By William Duncan MacMillan. Pp. xviii + 430. Price $ 2.00.

Theoretical Mechanics, An Introduction to Mathematical Physics. By Joseph Sweetman Ames and Francis D. Murnaghan. Pp. ix + 462. Price $ 2.00.

The Fundamental Principles of Quantum Mechanics with Elementary Applications. By Edwin C. Kemble. Pp. xvi + 611. Price $ 2.95.

Selected Papers on Quantum Electrodynamics. Edited by Julian Schwinger. Pp. xvii + 424. Price $ 2.45.

The Theory of the Potential. By William Duncan MacMillan. Pp. vi + 469. Price $ 2.25.

Vector Analysis with an Introduction to Tensor Analysis. By A. P. Wills. Pp. xxxii + 276. Price $ 1.75.

An Introduction to Fourier Methods and the Laplace Transformation. By Philip Franklin. Pp. x + 289. Price $ 1.75.

Introduction to Bessel Functions. By Frank Bowman. Pp. 134. Price $ 1.35.

The Foundations of Euclidean Geometry. By Henry George Forder. Pp. xii + 349. Price $ 2.00.

The Elements of Non-Euclidean Geometry. By D. M. Y. Sommerville. Pp. xvi + 274. Price $ 1.50.

An Introduction to the Geometry of n*-Dimensions.* By D. M. Y. Sommerville. Pp. xvii + 196. Price $ 1.50.

Lectures on the Theory of Elliptic Functions. By Harris Hancock. Pp. xxiii + 498. Price $ 2.55.

Elliptic Integrals. By Harris Hancock. Pp. viii + 101. Price $ 1.25.

The Dover Publications, Inc., has been rendering valuable service to the scientific community of the world by reprinting standard textbooks and classics in science, and bringing them out as cheap editions that are within the reach of any research worker of moderate means. A glance at the list of publications of the Dover series will impress one that the selection of these books has been inspired by the highest principles of scientific standard, and several of the books of the series, if not all, have been reigning for over a few decades as the undisputed classics in their respective subjects. The books on Mathematics and Theoretical Physics of which the present review is concerned, have special value to research students, since research under modern conditions demands a basic stock of mathematical knowledge and the Dover books supply just this need.

Statics and Dynamics of a Particle by William Duncan MacMillan is an elementary text-book on the subject, which covers approximately the syllabus of the B.Sc. Degree Course of the Indian Universities. Written in a clear style, the book is illustrated through the solution of a number of basic problems in astronomy, ballistics, transmission of power, elasticity and related topics.

Theoretical Mechanics, An Introduction to Mathematical Physics by J. S. Ames and F. D. Murnaghan provides a sound basic knowledge of the principles of mechanics that is necessary for a research worker in physics, theoretical or experimental. Starting from Newton's laws, the book leads the reader soon to advanced topics and gives an excellent account of general dynamical systems, Lagrange's and Hamilton's equations, the principle of least action, holonomic and non-holonomic systems, small vibrations, wave motion and Lorentz transformation.

Among the numerous books that have appeared on Quantum Mechanics, *The Fundamental Principles of Quantum Mechanics with Elementary Applications* by Kemble occupies a respected place and has been popular ever since it was published. A special aspect of this book seems to be the detailed discussion of the theory of eigenfunction expansion and orthogonal functions, and the elaborate treatment of the operator formalism of Quantum Mechanics. Containing a wealth of information both on the mathematical formation of Quantum Mechanics and the problems of atomic structure, the book will be of great value to every student of physics who desires to get a thorough understanding of Quantum Mechanics.

Of all the books of the series, the volume *Quantum Electrodynamics* by Julian Schwinger is perhaps the only one that deals with topics of current interest. Edited by one of the foremost figures in the field, the volume contains every paper that made its strong impact on the subject and has contributed to its development in its present form. The papers cover almost all aspects of Quantum Electrodynamics, and

the volume therefore serves even the purpose of a text-book while it has the additional advantage of unfolding the subject through its own creators, each with his characteristic individual style. This volume represents the struggle of the human mind to penetrate into the depths of Nature, the height to which mathematical imagination and ingenuity can fly, and yet tragically enough, the elusiveness of Nature to all such attempts.

The theory of the potential knows no limit for expansion and has enriched several branches of pure mathematics while lending its usefulness and application to such fields as applied mechanics. The republication of MacMillan's electrostatics, magnetostatics and quantum mechanics. The republication of MacMillan's long unavailable *Theory of Potential* will therefore meet the current need for an extensive text on the subject and will be welcomed by mathematicians, pure or applied, physicists and engineers. CONTENTS : Attraction of finite bodies, The Newtonian Potential function, Vector fields, Surface distribution of matter, Spherical harmonics and Ellipsoidal harmonics.

Vector Analysis with an Introduction to Tensor Analysis by A. P. Wills is a clear and comprehensive exposition of vector and tensor analysis and can be recommended as a text to all physicists and engineers unacquainted with this subject. Dr. Franklin's *Introduction to Fourier Methods and the Laplace Transformation* has been designed to introduce engineers, physicists, applied mathematicians, students and teachers of physical sciences, to the theory and application of Fourier series and Laplace transforms. CHAPTER HEADINGS : Complex quantities, Fourier series and integrals, Partial differential equations, Boundary value problems and Laplace transforms.

Introduction to Bessel Functions by Frank Bowman : As the title indicates, the book gives an introduction to the subject of Bessel functions.

The Foundations of Euclidean Geometry by Henry George Forder gives a connected and rigorous account of Euclidean geometry in the light of modern investigations. Although the propositions of Euclidean geometry are assumed to follow consistently from their axioms, critical examination has disclosed many vaguenesses and unproved assumptions in the Euclidean formulation. Further these researches have led to the discovery of non-Euclidean geometries, thus freeing the mind from its age-long bondage to the obvious and leading it to the newer conceptions of space that is common knowledge today. The book under review derives the Euclidean propositions from the axioms employing the mathematical discoveries of modern times and making the smallest number of assumptions possible. The book *must* be read by every teacher of geometry in schools and colleges.

Sommerville's *The Elements of Non-Euclidean Geometry* is a popular book on the subject and has been a standard text in the field. It can be read with delight by anyone with a good knowledge of high school algebra and geometry. The author outlines here lucidly the historical development of non-Euclidean geometries, the Playfair axiom and the consequences of its breakdown, elliptic and hyperbolic geometries and a few other topics like inversion and transformations. *An Introduction to the Geometry of n-Dimensions* by the same author was unavailable for many years and is perhaps the only book in English devoted to the subject of higher dimensional geometry. The author demonstrates in this book several representative topics of n-dimensional geometry which not only illustrate the extensions of three-dimensional geometry but reveal results which are unexpected and where analogy would be a faithless guide. The book treats the analytical geometry of n-dimensions both from the projective and metric points of views, and in addition contains several chapters on polytopes.

The reissue of Hancock's *Theory of Elliptic Functions* will be welcomed by all mathematicians, physicists and engineers. It is a monumental work on the subject and is unique for the wealth of information and details that it provides. Written in a rigorous and yet readable style, the book contains an exhaustive account of the theory of elliptic integrals beginning with formulas establishing the existence, formation and treatment of all three types (rational, simply periodic, doubly periodic) and concluding with the description of these integrals in terms of the Reimann surface. The author develops the theories of Legendre, Abel and Jacobi first and then gives an exposition of the $P(u)$, $\zeta(u)$ and $\sigma(u)$ functions of Weierstrass. Finally both these are interconnected by means of the universal laws of Reimann, who provided the most general theory of analytic functions by introducing the surfaces on which algebraic integrals may be represented. The book *Elliptic Integrals* by the same author is rather elementary compared with the above one and gives an introduction

to elliptic integrals of the first, second and third kinds and in addition provides a few tables associated with these integrals.

In spite of the cheapness of the books, the quality of printing is of a high order and is comparable with any highly priced publication.

K. S. V.

Mathematical Theory of Compressible Fluid Flow. By Richard Von Mises. Completed by Hilda Geiringer and G. S. S. Ludford. (Academic Press Inc., New York ; India : Asia Publishing House, Bombay-1), 1958. Pp. xiii + 514. Price $ 15.00.

This is Volume 3 of the series of monograph prepared under the auspices of the Applied Physics Laboratory, the Johns Hopkins University. It could not be finished by Richard von Mises before his death in 1953. At that time he had written only the first three chapters. The work was completed by his wife Hilda Geiringer and G. S. S. Ludford, who with the help of other collaborators like C. A. Truesdell have brought the work up-to-date by an exhaustive list of 'Notes and Addenda' at the end of the book.

The first chapter deals with basic equations, influence of viscosity, heat conduction, wave equation, subsonic and supersonic flows. The treatment is very scientific and new ideas like the specifying equation are introduced, which in general, may not be the same condition of state. Both the distinguishing features and the common points of subsonic and supersonic flows are brought out neatly. In chapter II general theorems are given on vorticity, irrotation motion, limit lines, hodograph representation and theory of characteristics. A number of examples are discussed in detail.

Chapter III deals with one-dimensional flow with viscosity and heat condition and discusses steady, unsteady flows and wave motion. The theory of shocks is discussed in great detail.

Chapter IV deals with plane steady potential flow. The hodograph method is fully discussed. A number of transformations are described. The following one given by the reviewer is not noted :

$$\phi_1 = \rho^{\frac{1}{3}} \cdot \phi, \quad \rho_1 = \rho^{\frac{1}{3}}$$
$$\psi_1 = \rho^{-\frac{1}{3}} \cdot \psi, \quad \rho_1 = \rho^{-\frac{1}{3}}$$
$$\frac{\nabla^2\phi_1}{\phi_1} = \frac{\nabla^2\rho_1}{\rho_1}, \quad \frac{\nabla^2\psi_1}{\psi_1} = \frac{\nabla^2\rho_1}{\rho_1}.$$

The last chapter develops Chaplygin's Method, shock theory and transonic flow. There are selected reference books at the end, an author index and a subject index.

The book does not lay much stress on the physical side of compressible flow. The mathematical side is very rigorously dealt with and will provide a great inspiration to any one interested in the subject. The historical side of the subject is fully dealt with in 'Notes and Addenda'.

B. R. Seth.

Electronic Measuring Instruments. Second Edition. By E. H. W Banner. (Chapman & Hall), 1958. Pp. 496. Price 56 *sh.* net.

Electronic instruments have surpassed in their usefulness all the previously known aids of the pure and applied scientists for accurate measurement and indication of electrical as well as non-electrical quantities. In recent years the development of electronic computing machines which carry out calculations with unimaginable speed and reliability, humanly impossible otherwise, is a remarkable achievement of the electronic engineers whose ingenuity in devising novel circuits seems to be the only limit to the marvels that electronics can play.

Employing certain well-known properties of electron tubes and circuits, a variety of measuring instruments are available commercially. Although scarcely any knowledge of the anatomy of such instruments and the principles involved in the circuitory employed therein on the part of the user is demanded, such a knowledge would satiate many inquiring minds. The book under review is intended to convey such information. The matter is divided into four parts. Part I : The characteristics of indicating instruments used with electronic devices. Part II : Electronic devices used in measuring instruments. Part III : Electronic instruments using the devices of Part II. Part IV : Quasi-electronic instruments and electronic devices used directly.

In Part II are discussed the fundamental characteristics of hot and cold-cathode valves, cathode ray tubes, photoelectric tubes, metal rectifiers and semi-conductor devices. The basic circuits in which these electronic devices are employed are briefly discussed. In Part III instruments using these are described. Of these, one finds detailed presentation of photoelectric measuring instruments and radiation measuring instruments. In Part IV instruments for measurement of non-electrical quantities such as vibration and strain measurement employing electromechanical transducers, automatic recorders, devices for the measurement of vacuum and a number of miscellaneous instruments are

discussed. The treatment adopted a nonmathematical, brief and does provide basic knowledge of the instruments. References to other books and papers for further reading for those who might be interested are also given.

Chemists and physicists would particularly find this publication useful as also instrument engineers.

A. J.

Conformal Transformations in Electrical Engineering. By W. J. Gibbs. (Chapman & Hall Ltd.), 1958. Pp. viii + 219. Price 45 *sh.* net.

For more than a decade now, publishers of text-books have been bringing out books on mathematical topics, which we are assured are specifically written for engineers and/or physicists. Sooner or later we find a book on almost every branch of mathematics on our book shelves designed for the engineer or the physicist. Some regret this trend, others hail it, but that is largely a matter on one's predisposition.

This book, on conformal transformations in electrical engineering, goes even one step farther in this direction. It is written for electrical engineers by an electrical engineer with the object of acquainting the practising engineer with the technique of conformal transformation in the solution of the practical problems in electrical design. As one would expect then, the style and exposition are not those of the mathematician or his new cousin, the theoretical engineer, who sometimes likes to rival him in his mathematical style. So much about the general flavour.

Although one of a series of advanced engineering texts, the book begins at an elementary level, the notions of complex numbers, central fields of force and mapping being developed in the first five chapters. The reader is then introduced to the Schwartz-Christoffel transformation which forms the central theme of this book. In working out special cases of the S-C transformation, the author develops the concepts of elliptic integrals and functions and other special functions like the Jocobi's Zeta and Theta functions. A number of problems involving S-C transformations of regions containing one or more right angles have been worked out in detail with appropriate discussions of their engineering significance. Particular mention may be made of the treatment of Carter's work on the problem of the field distribution between two poles separated by an air gap, one of the poles having slots cut in its face.

This book has distinctive merits to recommend it to those for whom it is intended. Devoid of mathematical sophistication, it presents the conformal transformation as the logical tool to be used in the solution of a certain class of problems in electrical machine design. Most of the chapters are short enough to give the novice a break in assimilating the new ideas as he encounters them.

The author has guarded himself against a possible accusation that the application of conformal transformation in other fields like elasticity and fluid dynamics has not been treated, by his careful choice of the title. However, conformal transformations have an equally wide field of application in radio and electronics in the design of many types of electron tubes which is still a branch of electrical engineering. The total absence of any reference to this important field limits the use of this book to only those concerned with electrical machinery.

B. S. RAMAKRISHNA.

Dairy Microbiology. By E. M. Foster, F. E. Nelson, M. L. Speck, R. N. Doetsch and J. C. Olson, Jr. (Macmillan & Co., Ltd., London), 1958. Pp. 492. Price 42 *sh.*

This text-book of Dairy Microbiology is a very welcome addition to the existing books on this subject. During the last 15-20 years considerable advances in various branches of Dairy Microbiology have been made and the present attempt of the authors, who are well-known research workers and teachers in this subject at different American Universities, is worthy of highest commendation. The book is divided into 15 major chapters, dealing with different topics such as micro-organisms of milk and dairy products; methods of controlling growth of micro-organisms; destruction of micro-organisms by physical and chemical agents; microbiological methods of examining dairy products; microbiology of milk on the producing farm; microbiology of market milk and related products; microbiology of condensed, concentrated and evaporated milks; microbiology of sweetened condensed and dry milk products and microbiology of ice-cream and related frozen products. In addition, there are chapters devoted to microbiology of lactic cultures, microbiology of fermented milks, microbiology of cheese, microbiology of cream and butter and there is a useful chapter on dairy plant waste disposal and utilisation of by-pro-

ducts. All the topics are dealt with in an exceedingly lucid style and besides giving a historical background, the fundamental principles involved, the most recent advances in each of these aspects and their practical applications in the industry have been clearly brought out. The chapters on milk on producing farm and market milk and related products are particularly useful and methods of cleaning and sanitization of utensils have been very thoroughly discussed. Also in the chapters on microbiology of lactic cultures as well as of cheese, the discussion is very thorough incorporating the latest published literature. The book is full of good illustrations and has got an excellent subject index.

In this country with the growing interest in starting of milk supply schemes and in the organisation of milk industry by the States and private enterprises, this book on Dairy Microbiology is bound to be very popular with all workers engaged in quality control work or teaching and research work in the field of dairy microbiology.

K. K. Iya.

Indigenous Drugs of India. Second Edition. By R. N. Chopra, I. C. Chopra, K. L. Handa and L. D. Kapur. (U. N. Dhur and Sons Private Ltd., Calcutta-12), 1959. Pp. xxxii + 816. Price Rs. 50·00.

The first edition of the book under the title 'Indigenous Drugs of India, their Medical and Economic Aspects' appeared exactly twenty-five years ago in 1933. Since then the senior author had remained quite active and had collected all the necessary literature, etc., in this connection and has brought out a Second Edition of the book which will be of real help to all those who are working in the field of indigenous drugs. Col. Chopra's experience in this field for over thirty years gives this volume the stamp of authority as a reference material and a book to be referred to by everybody.

The contents have been broadly classified into five parts as in the First Edition. Besides, one Addendum and three Indices also have been added.

Part I is devoted to the medical and economic aspects of Indian Indigenous Drugs. Detailed account has been given about a historical and general survey of the Indigenous drugs. Some new chapters describing the preparation of Indian Pharmacopœia, co-relationship of botanical classification of plants, their chemical constitution and physiological properties and newer trends in drug research have been included.

Part II deals with the potential drug resources of India with particular reference to pharmacopœial drugs of India. This part includes the list of British and Indian Pharmacopœial drugs growing in India.

Part III includes the drugs used in the indigenous medicine. This part has been further divided into two sections. Section I includes drugs of vegetable origin. This section includes many more drugs as compared to what it was in the First Edition. The authors have tried their best to give the complete information about the plant's botany, chemistry and pharmacology and also its clinical and therapeutic trials. Wherever necessary economics of its cultivation has also been discussed.

Similarly Section II gives detailed account about the drugs of mineral and animal origin. The mode of preparation, the pharmacology and the therapeutic trials of some well-known 'Bhasmas' have been dealt with in details. There is also a very good chapter on the drugs of animal origin, *e.g.*, on musks and cobra venom, etc.

Part IV of the book includes the Indian Materia Medica and is divided into four sections. The first section contains a list of vegetable, inorganic and animal products, commonly used in Unani and Ayurvedic systems of medicine. Section II is mainly devoted to the description of plants having (*i*) poisonous properties, (*ii*) plants producing dermatitis, (*iii*) reputed abortifacient and emmenagogue plants and (*iv*) insecticidal and pisticidal plants. Section III gives a list of plants claimed to have antiseptic or antitubercular or antidysenteric properties or the plants which are reputed to be effective against Cholera, Snake bite or Scorpion sting. Section IV is mainly devoted to aromatic or essential oil bearing plants. This gives a detailed picture about chemistry, pharmacology and therapeutic uses and the economics of these plants. Lichens, medicinal ferns and mushrooms have also been dealt with properly in separate chapters.

Part V which concludes the book deals with common bazaar medicines of India. There is a chapter on vernacular names and popular uses. Besides, an addendum and three indices dealing with (*i*) vernacular and popular names, (*ii*) chemical constituents and (*iii*) scientific names, have been added by the author to facilitate easy reference.

The present edition is undoubtedly the result of practical experience as well as hard labour and this task has been done very creditably. The printing and get-up of the book are of a

high order. The authors as well as the publishers should be congratulated for bringing out such a useful volume.

B. MUKERJI.

Metabolism of Lipids. (Published by the Medical Department, the British Council, 65, Davies Street, London W. 1). (*British Medical Bulletin*, Vol. 14, No. 3), 1958. Pp. 197-278. Price 20 *sh.*

Though not exhaustively covering the entire field of Lipid Metabolism, the articles presented in this Bulletin review most of the major issues that are in the forefront of this rapidly expanding field of study. Biosynthesis of fatty acids in various animal systems, with acetate as the precursor, has been reviewed in detail by Hele. "B oxidation in reverse" is broadly the process involved in the synthesis. Divergence in the anabolic and katabolic reactions as being due to the differential distribution of enzymes and co-factors in mitochondria and microsomes and the specificity of synthetic system in the mammary gland are interesting features of this review. The discovery of mevalonic acid and its significance as a precursor of cholesterol and the possibility of this compound acting as a key intermediate in the synthesis of many steroids is discussed by Cornforth and Popjak. Of the many factors influencing the biosynthesis of fat, Folley and McNaught have discussed the effect of endocrines on lipogenesis in the mammary gland. Utilizing this sensitive tissue and elegant isotope techniques, the role of insulin, glucagon and steroid hormones of adrenal cortex on lipogenesis has been studied. "The hormonal control of the circulating lipids" by Oliver and Boyd forms the continuation of the absorption studies. The fundamental change in concept that glycerides need not be broken down to fatty acids and glycerol, before absorption of lipids from intestines; some of the outstanding problems in the cellular and distributive phases of fat absorption and faulty intraluminar emulsification of fat in human subjects are the features of Frazer's article on 'Fat absorption and its disorders'. The importance of lipoproteins, both in absorption and in the transportation of lipids in the blood stream and the mechanisms of the removal of chylomicron lipids and unesterified fatty acids from the blood are some aspects of lipid metabolism presented in other chapters.

Diseases of the coronary arteries and disorders of the cardiovascular system, constitute major medical and public health problems of today. The intimate relationship between the increasing incidence of ischæmic heart disease, and the derangement of lipid metabolism; the essential fatty acid theory envisaging the importance of certain poly unsaturated fatty acids, *viz.*, linoleic and arachidonic acids in the causation of skin diseases and coronary artery involvement; the effect of fatty acids on coagulation and thrombosis and other advances in our knowledge of lipid metabolism in relation to human diseases are very ably presented and constitute highly informative chapters of this volume.

M. SIRSI.

Advances in Veterinary Science, Vol. III. Edited by C. A. Brandly and E. L. Jungherr. (Academic Press, Inc., New York; India: Asia Publishing House, Bombay-1). Pp. xi + 579. Price $ 13.00.

The present volume, the third in the series of the "Advances in Veterinary Science", contains nine essays written by people active in and familiar with specific areas of the different branches of veterinary science and animal husbandry. Of the ten authors, dealing with different subjects, 5 are from U.S.A. It would be advantageous for editors, Brandly and Jungherr, to concentrate on lesser number of topics giving thereby greater attention to a detailed and exhaustive survey in selected fields of veterinary research.

A varied fare is offered to the reader. Thus, the first review in this issue is by L. W. Hall and covers anæsthesiology. Therein, the author has discussed the principles and practice of veterinary anæsthesia with special reference to premedication, narcosis, relaxation and analgesia, including the use of antidotes and has very ably reviewed the recent advances in this field. The treatise will prove highly useful to veterinary surgeons engaged in work on operative surgery in the different species of domesticated animals and birds as well as students of surgery undertaking advanced studies in this subject.

J. R. M. Innes and I. Z. Saunders have written, jointly, the second essay on "Disease of central nervous system of domesticated animals and comparisons with human neuropathology". A ditinguishing feature of this article, the only one of its kind in veterinary neuropathology, is the compilation, in over hundred pages of all that is known about veterinary neuropathology, serving as an excellent source of information in a concise form, and of references to the litera-

ture on the particular topics covered in this comprehensive review.

The third, fourth and fifth articles deal with brucellosis in cattle (Thomsen), sheep and goats (Renoux) as well as swine (Cameron). Thomsen has summarised the work done in Scandinavian countries on several aspects of bovine brucellosis, which made possible the successful launching of a scheme for eradication of this disease from these countries. This may be of assistance in planning a similar campaign in India. Renoux has brought together data on brucellosis in goats and sheep, scattered very widely in the literature and it is pleasing to note that this reviewer has taken due notice of research work carried out in different parts of the world including India. He has succeeded in his stated purpose of bringing out the interest in and importance of caprine and ovine brucellosis as hazards to the health of man and animals. Cameron has dealt with swine brucellosis, with special reference to epidemiology, diagnosis and eradication, which is the shortest article in this book, the several other parts of which form a balanced and acceptable collection.

Similarly, the sixth and seventh articles on "Helminthic diseases" (Gordon) and "Antinematodal drugs" (Jones) are both thought-provoking, comprehensive and lucid in their scope and treatment of the subject. The section dealing with immunity in helminthic diseases is a redeeming feature of this review article by Gordon.

Vendeplassche has written an exhaustive review on "Artificial insemination of cattle with special reference to fertility and disease control". The author, in his concluding remarks, poses numerous problems in the field of artificial insemination and its bearing on sterility, spread of diseases and transmission of lethal genic characters, that remain to be tackled and solution of which will necessitate "well-organised teamwork and a well adapted extension service" as important and indispensable links for application and control of artificial insemination in practice.

The last chapter on "Clostridial disease of animals" is a first-rate account of an important and exceedingly difficult subject by L. D. S. Smith, a very experienced worker in this field. This essay, constituting a critical summary of the recent literature, will be of great value to any worker who wishes to have an up-to-date account of all that is known about diseases of animals due to anærobes and will be especially useful to any one undertaking research in this field.

As in volumes I and II, each part is followed by a copious list of references and critical selection of worldwide literature has been attempted. However, it would be a good addition to specify the time at which the survey of literature pertaining to the review was completed as a foot-note on the opening page as is the practice in the Annual Reviews of Biochemistry, Microbiology, *et cetera*.

There is a useful subject index and author index at the end and the volume is sold at a very reasonable price. It is undoubtedly a very valuable acquisition for all scientists and teachers and practitioners who are interested in veterinary and allied research. The book is packed with information which is judiciously presented and will be equally useful to the advanced worker as well as the serious student. All the chapters are of a uniformly high standard and the volume will be a most useful addition to any scientific library. Further volumes in the series will be keenly awaited.

The editing has been done in a most scholarly manner, and regarding the printing and get-up of the book, suffice it to say that it is another academic press volume. However, a printing mistake has been observed on p. 324 where the last line "*et al.* (1953)" should be printed as 15th line of the first para following the word "Rick" in the 14th line.

I venture to suggest to the Advisory Board that, while choosing subjects for review, due recognition must also be given to diseases that take a heavy toll of livestock in South-East Asia, like Rinderpest and Hæmorrhagic septicæmia and global representation of authorship should include, as well, veteran workers in these fields in different countries of Asia.

M. R. DHANDA.

Cosmic Electrodynamics. By J. W. Dungey. (Cambridge University Press, London N.W. 1), 1958. Pp. ix + 184. Price 32 *sh.* 6 *d.*

At the surface of the sun and of most stars, the temperature is so high that atoms are ionised, and the motion of charged particles generates strong electric currents and associated magnetic fields. It is no wonder, therefore, that electrodynamics plays an important role in problems of astrophysics and especially in phenomena related to our nearest star, the sun. The book under review presents the diverse electromagnetic phenomena that occur in the stars and the sun, such as the magnetic fields in the sun

and the stars, magnetic storms and auroræ, the acceleration of cosmic ray particles and interstellar fields, while at the same time giving, as the title indicates, an introduction to the subject of magnetohydrodynamics.

The emphasis of the book is decidedly on the theoretical developments in the subject, though at some places factual information has also been provided. The discussion in the first chapter on the order of magnitude of quantities involved in problems of cosmic electrodynamics seems to be very appropriate, especially for this subject wherein phenomena occurring in huge stellar scale are built up apparently from tiny atomic particles, and this will give the reader a clear insight into the mathematical quantities that he is handling. After discussing the motion of magnetic fields and a few static problems, the author describes some dynamic phenomena, the most important among them being the propagation of the magnetohydrodynamic waves. These are waves that pass through the magnetic lines of force, if these are pictured as elastic strings. In chapter six, the author discusses the problem of the acceleration of particles to high energies, which is related to the riddle of the origin of cosmic rays. All primary cosmic ray particles have energies greater than 10^9 eV., and some have energies as high as 10^{17} eV. Since there is no other conceivable mechanism by which the particles could acquire such tremendously high energies except the acceleration by some electric field, the origin of cosmic rays becomes a problem of cosmic electrodynamics. Chapter seven dealing with solar phenomena departs from the main theoretical trend of the book and in it the author summarises our observational knowledge regarding the sun, its dark spots, prominences, flares, etc. One wonders whether this departure is necessitated because no satisfactory theory exists as yet to explain the origin of the sun spot magnetic fields, and the host of phenomena associated with the sun spots such as their periodicity, their magnetic fields, the polarity of the fields, the Evershed effect are still a mystery!

The book besides contains two chapters on magnetic storms and Auroræ and ionospheric electrodynamics which will be of interest to meteorologists particularly. The bibliography at the end gives a list of references to the important papers on the subject published during recent years.

K. S. V.

Books Received

Nomenclature of Plants. By Herold St. John. (The Ronald Press Co., 15, East 26th Street, New York-10), 1958. Pp. vii + 157. Price $ 2.50.

Text-Books of Optics (for Advanced Studies). Part I. Geometrical Optics. By K. Ghosh, Art Union, 80/15, Grey Street, Calcutta-6), 1958. Pp. x + 480. Price Rs. 16·00.

British Medical Bulletin, Vol. 15, No. 1—*Haematology.* Edited by D. A. G. Galton. (Medical Department, the British Council, London W. 1), 1959. Pp. 83. Price 20 *sh.*

Tube and Semiconductor Selection Guide. Compiled by Th. J. Kroes. (Philips' Technical Library, Eindhoven ; India : Philips India Ltd., Calcutta-20). Pp. 34. Price Rs. 5·00.

Physics of Meteor Flight in the Atmosphere. By Ernst J. Opik. (Interscience Publishers, New York-1), 1958. Pp. viii + 174. Price $ 3.85.

Introduction to the Physics of Many-Body Systems. By D. Ter Haar. (Interscience Publishers, New York-1), 1959. Pp. viii + 127. Price $ 3.85.

The Potential Theory of Unsteady Supersonic Flow. By J. W. Miles. (Cambridge University Press, London N.W. 1). Pp. xii + 220. Price 45 *sh.*

Screening Procedures for Experimental Cancer Chemotherapy. By C. Chester Stock and others. (*Annals of the New York Academy of Sciences*, Vol. 76, Art. 3). Pp. 409-970. Price $ 5.00.

Symposium No. 6 of the International Astronomical Union—Electromagnetic Phenomena in Cosmical Physics. Edited by B. Lehnert. (Cambridge University Press, London N.W. 1). Pp. xii + 544. Price 50 *sh.*

Proceedings of the Third Congress on Theoretical and Applied Mechanics. (Indian Society of Theoretical and Applied Mechanics, Kharagpur), 1957. Pp. 362.

Genetical Theory of Natural Selection. By Ronald A. Fisher. (Dover Publications, Inc., New York). Pp. xiv + 291. Price $ 1.85.

Elasticity, Plasticity and Structure of Matter. By R. Houwink. (Dover Publications, Inc., New York). Pp. xviii + 368. Price $ 2.45.

SCIENCE NOTES AND NEWS

Asphondylia Sp. a New Record of Cocidomyid on *Sesbania speciosa* Flowers in Madras State

Sri. S. Venugopal, Agricultural College and Research Institute, Coimbatore, reports for the first time *Asphondylia* sp. a new record of Cocidomyid on the green manure crop *Sesbania speciosa* in Madras State.

Award of Research Degree

The University of Poona has awarded the Ph.D Degree in Physical Chemistry to Shri Mohan Chandra Tewari for his thesis entitled "Problems Connected with the Preservation of Timber".

First All-India Congress of Zoology—1959

The First All-India Congress of Zoology sponsored by the Zoological Society of India will be held at Jabalpur (M.P.) from October 24-29, 1959 on the invitation of the University of Jabalpur. Further information may be had from the General Secretary, Dr. B. S. Chauhan, Zoological Survey of India, 34, Chittaranjan Avenue, Calcutta 12 (India).

The Society for Analytical Chemistry, London

Dr. N. Jayaraman, Director, Essen & Co., Bangalore, has been elected as a Member of the Society.

The Marine Biological Association of India

The Marine Biological Association of India was founded at Mandapam Camp, to promote interest in marine biological and cognate sciences. The Association was formally inaugurated by the Hon'ble Mrs. Lourdhammal Simon, Minister for Fisheries and Local Administration, Madras State, on January 3rd, 1959. The following Office-bearers were elected: Dr. S. Jones (President), Prof. R. V. Seshaiya (Vice-President), Dr. R. Raghu Prasad and Dr. C. P. Gnanamuthu (Secretaries), Dr. R. P. Varma (Asst. Secretary), Shri K. V. Rao (Treasurer), Dr. P. N. Ganapati (Editor), Dr. R. Subrahmanyan (Joint Editor), and Dr. S. V. Job (Managing Editor). The official organ of the Association, the "Journal of the Marine Biological Association of India" is expected to be issued half-yearly. Membership is open to all interested. All correspondence may be addressed to the Secretary, Marine Biological Association of India, Marine Fisheries P.O., Mandapam Camp, South India.

Helium Separation by Diffusion

A diffusion technique for the separation of helium from a mixture of gases has been elaborated at the Bell Telephone Laboratories, U.S.A., and it promises to have application to the commercial isolation of the element from natural gas. Differential diffusion through glass is the principle employed and silica glass, which has a permeability to helium 1,000 times that to hydrogen, has been found the most efficient permeable material.

To obtain appreciable quantities of helium, the elaborators of the technique, K. B. McAfee and H. Kraft, point out, a large surface of glass must be exposed to the mixture, the glass must be thin, and a high pressure differential maintained between the two sides of the glass. In practice a bundle of the capillary tubes, each with one end sealed off, is encased inside a large glass or steel pipe, through which natural gas or impure helium is passed. The open ends of the capillary tubes are sealed into a common header which takes off the helium that diffuses through the walls.

Silica or Pyrex which can be drawn to tubing having an external diameter of 2/1,000 in., and a wall thickness of 2/10,000 in., and is capable of withstanding a compressive stress in excess of 1,000 atmospheres, is ideal for the separation of helium. It will withstand temperatures of more than 400° C. over long periods without deteriorating, and tests have indicated that a cell containing enough capillaries to occupy about 2 cu. yd. would pass nearly 1,000 cu. ft., a day of helium at room temperature with a pressure differential of 1,000 atmospheres, assuming a concentration of 1% helium. At 400° C. it would recover 1,000,000 cu. ft., of helium a day. A cell of that type might be placed directly in a gas pipeline for industrial use. A single diffusion step, it is claimed, yields helium containing less than 0·0009% hydrogen from a 90 : 10 hydrogen-helium mixture.

The only present producer of helium in the U.S.—the Bureau of Mines—has established several low-temperatures recovery plants in the

South-West to salvage some of the helium from especially rich, natural gas-helium mixtures. However, most wells do not produce a rich-enough mixture to warrant building such plants, so most of the natural gas-helium mixture is used for fuel, and the volume of helium so lost amounts to more than 10 million cu. ft. a day. —*Science Newsletter*: 4722-A.

Magnetism in the Galaxy

The 250 ft. steerable radio telescope at Jodrell Bank is being used by R. Hanbury Brown and colleagues in an attempt to measure the magnetic fields prevailing in the gas between the stars of our galaxy, the Milky Way. The telescope picks up radio waves from the very powerful radio star in the constellation of Cassiopæia. A cloud of gas in front of the radio star absorbs the radiation at the natural radio frequency of the hydrogen atoms, 1420 Mc./s. (21 centimeters wavelength).

If a magnetic field operates in the gas, the frequency of absorption is split into two frequencies by what is well known to physicists as the Zeeman effect. The magnetic field is expected to be extremely feeble (about a hundred-thousandth of a gauss) so that the separation of the frequencies would be only about 30 cycles per second.

Equipment to detect such a small difference has been devised by the Dominion Observatory of Canada, and makes use of different "polarisation" states in the two absorbed frequencies. The aerial employed consists basically of a waveguide containing two detecting probes inserted at right angles to each other.

The experiment began on 1st January, and has not yet been successful.—*The New Scientist*, February 1959.

Earth's Albedo

The earth's albedo, *i.e.*, the measure of its reflecting power, is indicative primarily of the properties of its atmosphere, and is of great interest as a characteristic of the earth as a planet in the solar system.

The value of the reflecting power of the earth has been redetermined recently by Andrei Kharitonov of the Alma Ata Observatory, as part of the IGY programme. The method employed was to compare the brightness of the moon's crescent (the part of its surface lit by the direct rays of the sun) with the brightness of the part of the moon lit by solar rays reflected from the earth. An albedometer designed at the Observatory was used in this determination. The new value for the albedo is 0·38 as compared to the earlier calculations of 0·39 by the French Scientist Andre Danjeon, and 0·42 by the Alma Ata Astronomer Kazachevsky.—*Soviet News*.

Particle Accelerator with Varying Magnetic Field

A cyclic accelerator with spatial magnetic field variation has been developed at the Joint Nuclear Research Institute, Dubna, near Moscow and has been in operation since January 1959. The existing types of charged particle accelerators are not sufficiently powerful to meet the growing requirements of nuclear physicists, especially with regard to the intensity, that is, the number of accelerated particles in the beam emerging from the machine. Development work on such accelerators is under way in many countries, especially, U.S.A. and Britain.

The new Soviet accelerator is distinct from the others in that the magnetic field instead of being constant is made to vary in space so that the field's lines of maximum tension fall into an Archimedes spiral. With this new type it is expected to produce particle beams thousands of times more intense than are obtained in the hitherto known high energy accelerators.

A report on the new accelerator has been sent to the international "Nuclear Instruments" maganize brought out in Amsterdam.—*Soviet News*.

Wax and Oil Recovery from Rice Bran

A practical method has been developed in America for recovering both oil and wax from rice bran in one continuous operation, using a single solvent, hexane. Previous methods for wax recovery required use of other solvents and at least two expensive steps for recovering both oil and wax. In the new method either of two procedures may be followed. In one, the oil is removed from the bran with cold hexane. Then hot hexane is used to extract the wax. Chilling the wax-hexane solution precipitates the wax, completing its recovery. The alternative procedure is to remove both rice oil and wax simultaneously by a single extraction with hot hexane. The wax is then precipitated by chilling and washed several times with cold hexane to remove any remaining oil. The rice wax recovered by the new method is a hard wax with a high melting point much like Carnauba and can replace the imported product in a number of uses.—*Chemical Products*, March 1959.

Nuclear Shapes

According to Rutherford's model of the atom it is customary to describe the nucleus as an extremely small, extremely heavy and extremely hard particle. While experiments have helped to fix the mass of nucleus to a high degree of accuracy, the question of its size, and more so its shape is still largely a matter of conjecture and depends on the nature of the experiments carried out for the purpose and the 'probes' used in them. These experiments include bombarding the nucleus with a variety of charged and neutral subatomic particles, probing the nuclear interior with its own atomic electrons and observing nuclear radiations. Although it is obvious that the size and shape of the nucleus can be described properly only in terms of actual experiments, an idealised model of the nucleus consistent with experimental facts will be an aid to stimulate further understanding of its structure.

The nucleus is composed of neutrons and protons bound together by nuclear forces, the origin of which appears to lie in their mutual interaction with pi-mesons. In attempting to know the size and shape of the nucleus two factors have to be considered, namely, the distribution of matter, *i.e.*, the nuclear particles, and the distribution of the nuclear force fields. To assume the nucleus to be a sphere will be an over-simplification of what in fact is an extremely complicated system of particles and forces.

A great deal of evidence has recently accumulated indicating that many nuclei possess shapes which differ considerably from spherical symmetry. In an article in *Science* (129, February 13, 1959, p. 361) L. Wilets has summarized our present knowledge of the shapes of atomic nuclei. According to this there are certain "magic numbers" in nuclear physics. If the number of protons and the number of neutrons within a nucleus are both "magic" the shape of the nucleus is normally spherical—magic numbers correspond to conditions of unusual stability. These nucleonic magic numbers are 2, 8, 20, 28, 50, 82 and 126. Examples of doubly magic nuclei are oxygen-16, calcium-40, calcium-48 and lead-208.

Consider now a nucleus slightly larger than a doubly magic nucleus. An additional neutron or proton can rotate freely within the doubly magic "core"; in so doing they exert a centrifugal force and deform the nucleus into an oblate spheroid.

If, on the other hand, there is one fewer neutron or proton than is needed for a doubly magic nucleus, this can be regarded as a hole, rotating in a similar way, but exerting a negative pressure on the nuclear surface. It thus deforms it into a prolate spheroid.

This simple view would suggest that midway between magic numbers in the table of isotopes there would be a switch from the oblate to the prolate: in fact, the prolate predominate.

There is also evidence that some isotopes in the neighbourhood of radium have pear-shaped nuclei.

Nuclear Raman Effect

Deformation of the nucleus shows itself as deviation of nuclear electric field from spherical symmetry leading to the quadrupole moment of the nucleus. A rotating or oscillating quadrupole can radiate or absorb electromagnetic energy. It is known that in nuclear photo-effect the cross-section for absorption of photons shows a giant resonance which varies with atomic weight from about 20 Mev. for light nuclei to about 14 Mev. for heavy ones.

In the case of nuclei with non-spherical equilibrium shape, the photo-effect will depend on the orientation of the nucleus with respect to the direction and polarization of the incident photon. Thus the giant resonance characterising the photo nuclear process is expected to split into two components corresponding to vibrations of the nucleus parallel and perpendicular to the axis of the spheroidal nucleus. Recently experimental evidence has been obtained for such a splitting.

Also the dependence of the photo-effect on the nuclear orientation provides at the same time a coupling to the rotational motion. The scattering of photons will be accompanied with the excitation of rotational states. The phenomenon is analogous to the Raman Effect in molecules.

In a paper on "Nuclear Raman Effect" (*Nuclear Physics*, 10, 1959, No. 2) Maric and Möbins have discussed the dependence of the photo-effect on the nuclear orientation and computed the cross-section for the Nuclear Raman Effect in the case of inelastic scattering of gamma-rays accompanied with the excitation of rotational states of strongly deformed nuclei.

An experimental study of such processes might provide additional information about the structure of the photo-resonance in deformed nuclei.

New Value for Earth's Oblateness from Measurements of Satellite Orbits

The oblateness of the earth is defined as the difference between the equatorial and polar

radii divided by the equatorial radius. The accepted value for this ratio is 1/297·1. A more precise value has been calculated making use of the data on the orbits of artificial satellites.

The main perturbations to the orbit of a near Earth-satellite are caused by (*a*) the oblateness of the earth and (*b*) the drag of the earth's atmosphere. The effect of air drag is to reduce steadily the length of the major axis and the eccentricity of the orbit, while the effects of the polar flattening are (*i*) to rotate the orbital plane about the earth's axis and (*ii*) to rotate the major axis of the orbit in the orbital plane. Of these perturbational effects, the rotation of the orbital plane which can be measured very accurately should provide new information about the earth's gravitational field in which the satellite moves.

In an article in *Nature* (182, September 6, 1958, p. 640) R. H. Merson and D. G. King-Hele have described a method of exploring the earth's gravitational field from analysis of kinetheodolite observations of satellite orbits. The usual expression for the gravitational potential due to the earth (of equatorial radius R) at an external point distant r from the centre, contains in addition to the main first order term (R/r), the perturbation terms of the second and fourth harmonics, *viz.*, $(R/r)^3$ and $(R/r)^5$, whose coefficients may be taken as J and D respectively. The expression for the mean rate of rotation of the orbital plane for a near earth-satellite in this gravitational field involves the coefficients J and D, and the orbital angle θ. From the data available for the orbits of Sputnik II ($\theta = 65°$) and Vanguard I ($\theta = 34°$), Merson and King-Hele have obtained the values, $J = 1624{\cdot}6 \times 10^{-6}$ and $D = 6 \times 10^{-6}$ (*Nature*, 183, March 28, 1959, p. 881). From these values of J and D, the new value for earth's oblateness has been calculated as 1/298·20. From information available on Explorer IV ($\theta = 50°$), it has been found that the sixth harmonic of the order of 10^{-6}, does not significantly affect the above value.

Early Tetrapod Life

The first tetrapods arose in the Devonian period. The evidence indicates that this was a time when the land areas in which the tetrapods evolved were subject to seasonal droughts or periods of aridity. A. S. Romer has suggested on various occasions that tetrapod limbs did not develop as an adaptation to terrestrial life itself, but, rather, as an adaptation which would assist an aquatic animal living under drought conditions to shift from drying pools to those that were less fleeting.

In a recent paper Romer [*Evolution*, 12, 365 (September 1958)] emphasizes that there were two distinct chapters in tetrapod history : (*i*) development of limbs giving potentiality of terrestrial existence, and (*ii*) utilization of these limbs for life upon the land. These two events need not have occurred synchronously ; in fact, Romer believes that they were separated in time by many millions of years. The development of limbs took place during the Devonian period, when the climate and lack of available food supply on land did not favour terrestrial vertebrate life. The beginning of actual life on land did not occur until the upper Carboniferous period, very probably during late Pennsylvanian time, when the world climate and the evolution of insects made available the supply of animal food necessary for the existence of terrestrial vertebrates.—*Science*, Vol. 129, p. 533, 1959.

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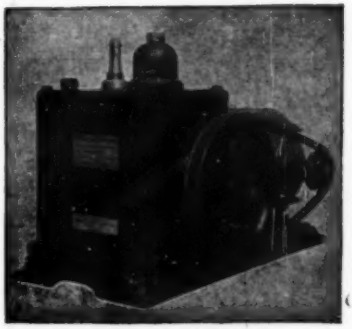

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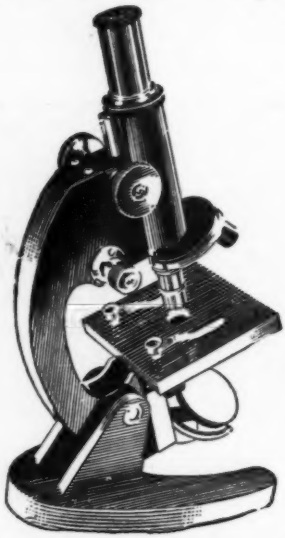

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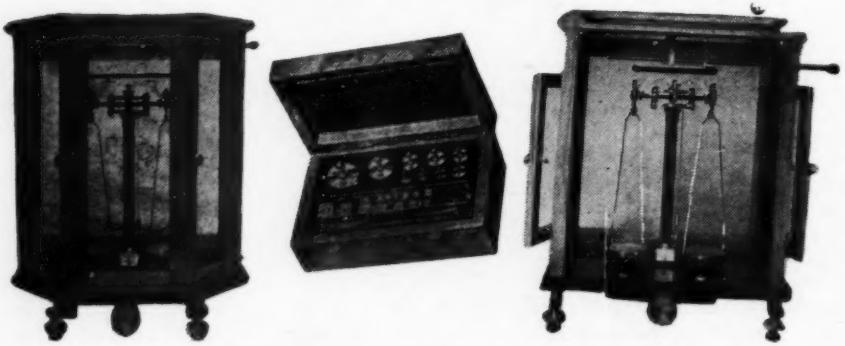

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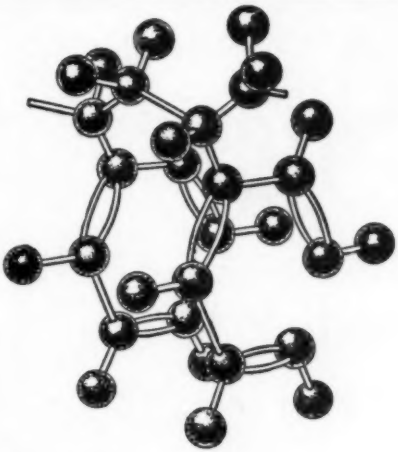

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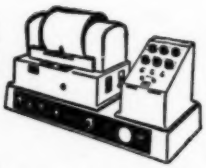

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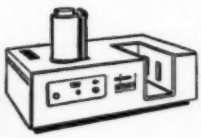

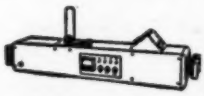

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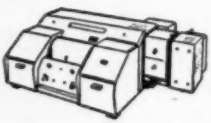

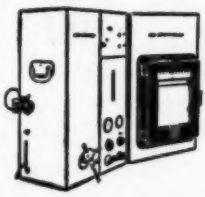

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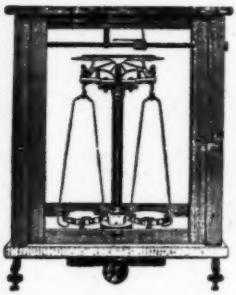

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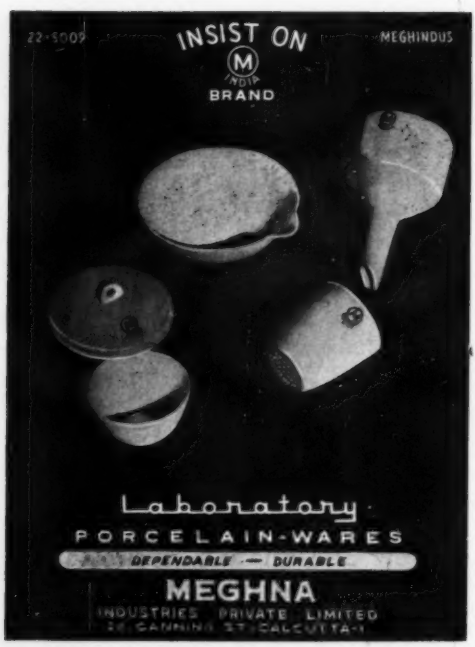

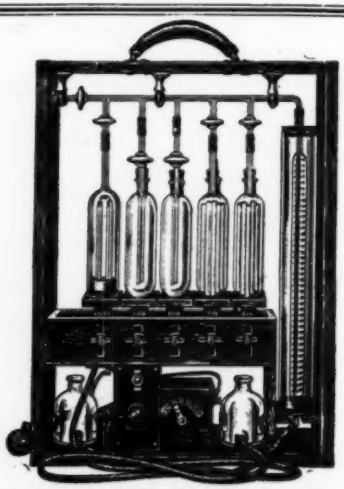

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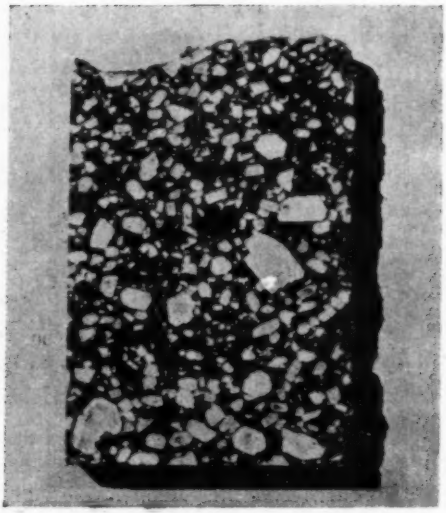

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